THE

TROPICAL AGRICULTURIST

VOL. LXII. PERADENIYA, FEBRUARY, 1924. **No. 2.**

THE VEGETATIVE PROPAGATION OF TEA.

In the early days of tea planting in India trials were made at propagation by means of cuttings. In certain cases this method was found to have been reliable, while in others unfavourable results were obtained. It was obvious that if the weather conditions were suitable more satisfactory results were secured than when the weather conditions were unfavourable.

During the past year some trials with the propagation of tea from cuttings were made at the Botanic Gardens, Hakgala. The Curator of these gardens had previously had considerable success with the propagation of Camelias when the cuttings were not less than 18 inches in length and when not less than 8 inches of the cuttings were inserted into the ground. A similar method was tried with tea and has been found to be quite successful.

In cases therefore where tea seed is short and particularly on the wetter side of the island it is thought that the propagation of tea by means of cuttings is well worth a trial and this is especially the case when vacancies in a field of uniform jât are required to be filled in.

The question of the vegetative propagation of tea has received special attention in Java and a special bulletin has recently been published in English which gives a concise account of the experiments that have been carried out in that country.

The introductory portion of this bulletin is reproduced in the present number of the TROPICAL AGRICULTURIST and it can be concluded therefrom that crown grafting, rectangular patch-budding and upright stem layering between halved sections of bamboos can be recommended.

In Ceylon, rectangular patch-budding has been experimented with, but has not been successful. Crown grafting has not yet been attempted.

These two methods are suitable when it is desired to make seed gardens of uniform jât of a selected type, and should be experimented with by all those who desire to propagate varieties of exceptionally good qualities. Inferior jât seed-bearers can be re-placed by these methods and the quality of the seed garden thereby improved.

The upright method of stem layering can be recommended for more general trial. The best results have been obtained with two-year old shoots on pruned trees. These are ringed for a width of about one-sixth of an inch just below a bud or young side-branch which has been cut off. The cambium is then destroyed by rubbing the wood with the back of a pocket knife, and the leaves or twigs just above the ring-wound are cut away. This ringed bark is then covered with a bamboo section split into two halves, which are bound tightly together and then filled loosely with leaf mould.

Layers made by this method root within nine months and can then be severed from the parent tree, topped about one foot above the bamboos and planted out in the same way as a stump grown from seed is dealt with.

It is recommended that these layers should be shaded during the first year after planting and the use of green manure plants is advocated.

This method of reproducing tea by means of layers can be employed when tea seed is short and is particularly to be recommended for the filling of vacancies and for securing a field of uniform jât.

The experiments in Java with growing cuttings have not been successful, but these were carried out in beds made of moist sand, while the trials in Ceylon were conducted in nursery beds made of ordinary soil with an admixture of leaf mould. It has yet to be demonstrated whether the cuttings which have been raised this year will stand transplanting well and produce good healthy bushes. Sufficient has been done to warrant further trials being made and now that the results of experiments in Java have been made available in concise form it is to be hoped that tea estates will make trials of their own.

The tea industry should not be content with its present jâts of tea and every attention should be given to selection of special types and to their propagation by vegetative means.

TEA.

VEGETATIVE PROPAGATION OF TEA.

MR. A. A. M. N. KEUCHENIUS.*

In connection with the selection experiments conducted at the Government's Cinchona Plantations "Tjinjiroean," altitude 5,000 ft.—6000 ft. near Bandong (Java) by the Selection Department of the Tea Experimental Station, it was essential to establish a method of vegetative propagation allowing the inferior trees in a seed garden to be easily converted into grafts from the superior ones. In this way seed gardens of uniform type and consisting of a small number of carefully selected trees may be obtained. Besides, grafting or budding may be useful—firstly, to convert inferior plucking bushes into good *jat*, immune or highly-yielding plants—secondly, to obtain an absolutely uniform (isogenous) material for pruning, plucking and similar experiments.

The subsequent methods were put to the test :

1. *Crown-grafting.*

The following factors were found to exert a notable influence on the result : *a.* shade during first period after grafting ; *b.* innate faculties of parent tree and stock ; *c.* stage of development of the scion buds ; *d.* diameter and age of scion ; *e.* length of scion; *f.* diameter of stock ; *g.* age of same ; *h.* age of parent tree ; *i* climatic conditions. By a judicious arrangement, the proportion of successful grafting was raised to 74% on an average, a percentage of 60-75% being easily obtained.

2. *Rectangular Patch-budding.*

Success was obtained in about 87% of the cases, while 75-85% is a fair estimate.

It is important to compare this method, which was successfully developed by MESSRS. MAAS and SLOTEMAKER in Sumatra, with the preceding one from an economic point of view. Grafting, then, appears to be easily first, at least on high-situated estates, notwithstanding the lower vitality of grafts as shown by the above figures. One 10-year-old parent tree at Tjinjiroean yields about 150 scions on an average, twice in a season ; some trees produce up to 1,000 scions at a time ; on the other hand, it was impossible to obtain more than 50 buds from one tree in one season, but perhaps this figure might be increased by suitable pruning. Again, the grafting and budding processes are performed by a skilled workman at a rate of about 135 scions or 55 buds a day (6 hours), not including the cutting of the scion ; if the operation is done at the nursery, 200 grafts and 80 buddings respectively may be obtained. Putting the price of one 2-year-old stump at 1½ cent. a full-grown crown-graft will cost about 4 cents, one budding 4½ cents. Hence one Hectare (2½ acres) of ordinary plucking gardens, made with grafting or budding, would cost 210 or 250 guilders

* Summary of a report in *Mededeelingen van het Proefstation voor Thee*, No. LXXXIV, 1923).

respectively, *more* than the same garden planted with stumps. A considerable reduction of costs would, however, be brought about if parent trees were found combining a high leaf-yielding capacity or other desirable features with a natural aptitude for grafting or budding; in fact some trees have been found where crown-grafting was successful in 85% of the grafts made.

3. *Upright stem layering* between halved section of bamboo-stem.

Recently made layerings are much weaker than stumps and should be handled with much care. In one instance 210 out of 300 layerings took root (70%), and of these 156 (52% of the original number) survived when planted out. The applicability of this method is therefore confined to such cases where it is thought essential to avoid inserting the root system of another individual (stock) between the foliage and the soil, *e.g.*, for manuring experiments.

On comparing the bamboo method with a fibre wrapping (so-called coir of the coconut, or *eju*-fibre of *Arenga* (*saccharifera* Labill). It proved very much superior to these materials which are in vogue with the Javanese. Figs. 14-15* illustrate the difference in root-formation, which was attained after 9 months in 83% of the bamboo layerings, 62% of the coir and less than 15% of the *eju*-fibre wrappings.

4. *Inarching.*

This is the only method leaving the supply of nutrients to the scion unimpaired, so that it may be kept joined with the stock for an indefinite period and there is practically no risk of failure (98% of the inarched stocks succeeded). It is, however, tedious and expensive and therefore scarcely applicable on a large scale. It is a good plan to have one-year-old stocks planted round the parent tree either in the ground or in pots or bamboo-crates, and to employ two men one bending and pressing the mother branch against the stock, the other making the corresponding incisions and binding both parts together. Finally the junction is covered with wax and fixed by a prop stuck in the earth.

5. *Veneer-grafting.*

This method is extensively used in *Cinchona*, and therefore has also been experimented with in tea for many years. It has, however, been abandoned, as it was impossible to raise the figure of successful graftings above 37%, whereas the average success did not exceed about 20%.

6. *Shield-grafting.*

This method recommended by MR. VANLEERSUM as early as 1912 has been tried on a large scale; the best conditions (season, stage of scions and stocks, etc.) were carefully investigated; the results were, however, about the same as in Veneer-grafting.

7. *Cleft-grafting.*

The results obtained with this method, customary with coffee, were extremely bad: only 4% of the graftings survived.

8. *Shield-budding.*

The vigour of the plants obtained by this procedure was remarkable; it is however worthless for tea selection, as only 2% of the buddings were successful.

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* Not reproduced.

9. Budding by veneering.

Although this method resembles very much the rectangular patch budding and was carried out by skilled rubber grafters, the experiment was a complete failure.

10. Splice-grafting.

None of the grafts made in this way survived.

11. Crown-grafting by triangular inlaying.

This method was tested in rather a small number of plants ; the success was nil.

12. Layering.

It is said that this method and the following one are much in use in Formosa. Two variants were tried : 1. one-year-old shoots were ringed and bent down, then covered with earth and fixed by two hookpins ; 2. all stocks were decapitated and in each 3-5 vigorous shoots were kept and ringed, then the plants were earthed up 4 inches above the ringed portion. The latter procedure gave better results than the former, and within 9 months produced an abundance of hair roots in 94% of the shoots. They are then, however, not yet self supporting, so that they should be very carefully separated from the parent tree and transplanted.

13 Culling.

This operation, consisting in placing branches, stripped of their leaves, in moist sand, is on the whole more successful in herbaceous plants than in trees with hard wood such as tea. Accordingly, only 2% of the tea cuttings survived.

The following tabular statement may convey an idea of the relative growth resulting from the principal methods, 10-14 months after grafting.

Method	Grafts		
	Length increase.	Diameter increase.	Stocks, diameter increase.
1. Crown-grafting ...	51%	47%	28%
5. Veneer ,, ...	46%	33%	18%
6. Shield ,, ...	27%	48%	21%
2. Rect. patch budding ...	35%	57%	23%
8. Shield budding ...	56%	53%	21%

—MEDEDEELINGEN PROEFSTATION VOOR THEE, No. LXXXV.

SOME OBSERVATIONS ON STEM AND ROOT DISEASES OF TEA.

STEM DISEASES.

During the past few months there has been a considerable increase in the number of specimens of stem diseases received at Tocklai. The writer paid a short visit to Cachar and the Dooars recently and studied some of the diseases concerned on the spot.

CORTICIUM spp.

The commonest form of stem disease was characterised by wounds extending along one side of the stem. These wounds had sometimes

healed leaving a long scar, but in many cases the branches had commenced to decay and large cankers had formed.

It was found that these cankers were not formed by the same fungus in each case, but that a number of fungi were responsible for similar diseases. The commonest of these appeared to be species of *Corticium*. This type of fungus produces very fine threads, which run over the bark and often extend to the leaves. They are almost invisible in one species, while in another they produce visible cords somewhat resembling Thread blight, but quite distinct in character. In most cases the specimens received at Tocklai bore no trace of these fungi, only the wounds and scars were apparent. These were often infected by other fungi and frequently the bushes were also attacked by *Thyridaria tarda*. As the fungi concerned were of the kind unlikely to produce cankers further investigation was carried out to ascertain the original cause of the cankers. Later, the various stages in the formation of the cankers were observed, and the fungi causing them were isolated.

In the Dooars and in Cachar a species of *Corticium* was observed which was obviously attacking the bark of the tea, in most cases killing it in long strips, sometimes on the upper surface but more often on the under side. The young red wood is often completely ringed and dead. The external mycelium of the fungus is white and occasionally collects together in threads of sufficient thickness to be visible to the naked eye. The fructifications of the fungus are to be found on small twigs which have been dead some time and are about to fall off. The fructifications are pinkish white patches about $\frac{1}{8}$ in. to $\frac{1}{4}$ in. in diameter. The fungus does not appear to attack the leaves at all, but many of the leaves die because of the reduction in food supply due to the damage to the stems.

Another species of *Corticium* was also found often on the same gardens. This was able to attack the leaves in a manner resembling the Black Rot found in Assam, but the fructifications did not appear to be found on the leaves, but on the young stems before the death of the latter. In this case the fungal mycelium was invisible to the naked eye. This fungus resembles the one described by PETCH as being common in Ceylon. This fungus appears in patches of tea. The tea may appear quite healthy one day and the next day the leaves on a patch of 20 or 30 bushes suddenly become mottled with red patches between the veins. The progess of this disease is extraordinarily rapid and in a few days the bushes seem to be almost dead, all the leaves and young shoots having died back. The bushes recover to some extent, but are soon reattacked, and if untreated will die right out.

If the bushes survive the attacks of these fungi for any length of time, the bark begins to grow over the portions which have been killed by the *Corticium* and strips and ridges of new cortex are produced. In some cases the wound is completely covered, but as a rule other fungi attack the dead bark and spread thence to the wood, causing the damaged branches to decay and ultimately die right back. In Cachar one of the commonest is *Auricularia Auricula judiæ*. The fungus produces brown gelatinous fruits like ears. It kills the branches and in time extends to the roots. It is a wound parasite and does not appear to attack the tea except through

wounds caused by other agencies. Another common fungus which follows the wounds caused by *Corticium* is *Thyridaria*. This fungus attacks the whole bush, causing it to become moribund and eventually killing it altogether. The characteristics of this disease have been described before on a number of occasions.

PESTALOZZIA sp.

On two gardens in the Doors a stem disease was found on areas which had been badly attacked by Mosquito blight in former years. The stems in this case bore curious swellings, not continuous, like those produced by the *Corticium* species, but at irregular intervals. In many cases the early stages are characterised by a row of small cracks through which new bark appears. These were usually near the axils of leaves on red wood. The fungus present in these cankers was isolated and grown in pure culture. It produced spores in time and was found to be similar to, if not identical with, that producing Grey blight—*Pestalozzia theæ*. The stems of undiseased tea bushes were inoculated with the fungus in various ways. It was found that the fungus was only able to infect at wounds. The characteristic swelling developed where the fungus was inoculated into pin pricks. Stems similarly pricked but not inoculated did not produce the swellings. To make assurance doubly sure the fungus was re-isolated from the artificially produced swellings. It would seem that the fungus infected the plant at the punctures made by the female mosquito when depositing her eggs. The fungus, however, causes the tea to die back and seriously reduces crop.

NECTRIA CINNABARINA.

Another stem disease is doing considerable damage. This is caused by *Nectria cinnabarina*. In this case cankers are rarely produced, but sooner or later the tiny fructifications appear and are easily recognisable. The stems die back slowly and the bush becomes moribund,

VELVET BLIGHT.

From time to time a curious disease of stems known as Blue Velvet Blight appears in Darjeeling. This fungus forms a bluish coloured velvety coating on the stems and the stems frequently die back. Recently a similar fungus has been found in a number of places. It differs in colour, however. It is brown, almost the same colour as brown root rot. This fungus looks very alarming but apparently does no damage. A seedling covered with the fungus was received by post in January last. As it was alive on receipt it was planted in a pot. It is still alive and very vigorous, in spite of its thick overcoat of fungus. However, it is possible that in moister climates the coating of fungus would harbour other disease-producing organisms. It is therefore desirable to strip off the fungus wherever it is found. The fungi in both cases are species of *Septobasidium*.

GENERAL TREATMENT OF STEM DISEASES.

In all the above-mentioned stem diseases, with the exception of the last, it is necessary to proceed as follows :—

1. Cut out all the diseased wood well below the obviously diseased portions. This should be done as soon as possible

2. The prunings should in all cases be burned at once.

3. Immediately after 1 and 2, spray thoroughly all diseased patches and the bushes in their vicinity with Lime sulphur solution (See "Notes on the Spraying of Tea" published by the Scientific Department of the Indian Tea Association). Stock solution diluted 8 times with water

In the following cold weather.

4. Go over the sections again and wherever the disease is still present repeat the treatment.

5. Spray all sections on which the disease has been found with Lime sulphur solution. Stock solution diluted 5 times.

6. Paint all the cuts on heavy pruned or cut-back tea with the following fungicidal paste.

Dissolve 4 lb. of Copper sulphate by suspending it in a bag in 1 gallon of hot rice water. When cold add sufficient slaked lime to form a paste. This paste is more satisfactory than that suggested in previous Quarterly Journals.

It is most important that treatment should be carried out as soon as possible, as most of the diseases concerned spread rapidly, and if a large area is allowed to become infected the loss in crop and the cost of treatment are likely to be very considerable.

ROOT DISEASES.

In addition to the abnormal increase in stem diseases there have been a number of exceptional cases of root disease. Early in the season the writer investigated a root disease closely resembling that caused by *Thyridaria tarda*. The latter disease is invariably found on sandy soils. The case in question was on a stiff, very hard soil. The fungus was a *Diplodia* like *Thyridaria tarda*, but different in some respects. The small black dots produced on the dead roots were in this case often accompanied by tufts of white mycelium. In this respect it resembled the description given by PETCH of Diplodia root disease found in Ceylon.

PORIA SPP.

About the same time a number of specimens were received bearing fructifications of species of *Poria*. PETCH says that the commonest root disease in Ceylon is caused by *Poria hypolateritia*. It is curious that in the tea districts of North-East India so few specimens of *Poria* species have been found on tea. This year, however, at least two distinct species have been found on tea. In all cases the plants were growing in stiff soils.

Poria species produce thick stands of fungus, resembling roots, which spread starwise both outside and under the bark of the roots. The strands of mycelium often spread upwards to the branches. After the death of the bush, sometimes before, the fructification forms. This is a plate adhering to a branch. The plate is eventually covered with minute pores. The colour of the plate and of the strands of fungus varies with the species.

The commoner species has a yellowish brown fructification and white or cream mycelium. This later becomes black and in this stage may be mistaken for *Sphærostible repens*. Another species has a pinkish coloured fructification and mycelium of a similar colour.

POLYPORUS SP.

In addition to the *Porias*, on the same class of soil species of *Polyporus* has also appeared on tea. This has white bracket-like fruits produced in clusters just above the collar. The mycelium is white and somewhat fluffy. It spreads over the roots in thick strands.

FOMES LUCIDUS

Fomes lucidus was also found this year more frequently than usual. The fungus is easily recognised by the hard bracket fructification it produces on the dead stumps. The upper surface of the bracket is coloured red brown and often presents a varnished appearance.

On one garden in the Dooars, on a small section of stiff black soil, all the above-mentioned diseases were represented and another one in addition. In this case the Sau trees, particularly the *Albizzia moluccanas*, were dying back, and an examination of the roots showed that the dying back was caused by root diseases and the root diseases had spread to the tea from them.

SOIL TREATMENT VERY IMPORTANT.

All the above-mentioned diseases were found on stiff soils, and in devising treatment special attention has to be paid to the peculiar soil conditions. In the case of the diseases caused by species of *Poria*, *Polyporus* and *Fomes lucidus* mere removal of the dead roots is not sufficient as the fungus actually grows through the soil. By digging trenches round the diseased bushes and removing the latter carefully the disease may be checked, but it is unlikely that it will be eradicated until the physical condition of the soil is improved. In some cases, owing to the nature of the soil and the climatic conditions, it is impossible to bring about satisfactory æration by drainage. Hoeing when the soil is soaking wet makes matters worse, while hoeing when it is dry is almost impossible owing to its excessive hardness. It is necessary therefore to cultivate this soil just at the right time—when it is not too wet nor yet too dry. Such soils should not be hoed when too wet to crumble. Thorough cultivation at this time will go a long way towards checking the disease. The corpses and diseased plants must of course be removed and burned as soon as possible and a heavy dressing of lime applied to the soil wherever the diseases appear. In addition, if the chemical conditions of the soil requires it, the whole of the stiff area should be heavily limed at the time the thorough cultivation is given.—A. C. T.—QR. JOURN. OF SCI. DEPT. OF THE INDIAN TEA ASSN., Pt. III., 1923.

BLISTER BLIGHT OF TEA.

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Blister blight caused by *Exobasidium vexans* has been known to affect tea in India as far back as 1868. The disease makes its appearance chiefly during the rainy season. The first symptom is the appearance of small, circular, translucent, pale or pinkish spots on the leaves. In some cases the spot may be deep red on both sides of the leaf. A spot enlarges generally to about $\frac{3}{5}$ of an inch or rarely to almost an inch. On the upper surface of the leaf the spot becomes gradually depressed into a shallow cavity and on the lower surface it bulges slightly, thus forming a blister from which the blight takes its name. The upper concave surface is smooth, pale green, yellowish or pinkish and sometimes deep red, while the lower convex

surface remains dull and becomes first Grey and powdery and then pure white. The lower surface produces colourless spores which give the white appearance to the under side of the blister. In few cases the form of blister may be reversed, the blister appearing on the upper surface and the hollow below. Both forms may be found on the same leaf, but the white spore-bearing surface is always most evident in the lower surface. Gradually the white surface of the blister becomes dark brown or almost black and the blister shrinks to a flattened patch in the same plane as the rest of the leaf surface.

If a blister forms on the midrib, the leaf often folds or rolls up; if near the margin the leaf may curl. On a young leaf, the blister sometimes appears on or near the leaf stalk and then besides being twisted, the leaf gets stunted. Blisters that come on the midrib have often an irregular outline, spreading lengthwise rather than across the leaf. The number of blisters on a leaf may vary from one to twenty. Very often the blisters run into one another, causing much distortion or curling of the leaf. Fresh young leaves and buds are liable to infection, but leaves over four weeks old are immune.

After the disease has appeared on the leaves, it spreads to the leaf-stalks and the young succulent green stems, but here the appearance of the disease is not so conspicuous, though the damage caused is more serious. No blister is formed on the stem though the course of the disease is the same. The colour of the young spot is very similar but the red colour is not developed. The spot which is circular at first, becomes elongated along the stem and gradually extends round it. The affected area gets slightly swollen and when the spore-formation stage is reached, the spot appears grey, instead of white like the blister. The disease eats into the young stem so that the leaves and buds above it wither and blacken and the stem bends over at the affected part.

The method of attack in the field is often very erratic. The disease does not appear to begin in one place and spread from there but may appear anywhere and spread rapidly. Several bushes may get badly diseased and scattered bushes may get very lightly affected. Certain bushes appear to be immune from the disease and remain unaffected, though the surrounding bushes may be badly attacked. When after a few days of sunshine a spell of wet weather recurs, a few blistered leaves may be seen scattered throughout an apparently healthy patch. Shade favours the blight, and it is worse in moist, shady localities. It was frequently found that bushes under trees grown for shade had the disease, while the exposed surrounding bushes were free, and when both were affected, the bushes under shade suffered more severely. Bushes that had been lightly picked in order to strengthen them were occasionally the worst attacked. This is because in light picking more succulent leaf is left leaving a greater amount of suitable surface for the disease to work on. Still in spite of the blisters the bushes gained more by being spared than they lost because of the disease. In the young, succulent leaves of heavy pruned bushes, the blight develops very vigorously and may destroy nearly all the leaves ; ninety per cent. of the bushes may have all their leaves blistered or fallen off and even the young buds may be blistered and stunted.

BLISTER BLIGHT OF TEA

Reproduced, by permission, from Bulletin No. 18, Agricultural Research Institute, Pusa, India.

The disease is severe in localities with a high rainfall. Evidence points to the disease being more severe at high elevations and worse between 4,000 and 5,500 ft. The real factor with regard to severity is not elevation but moisture.

The blight attacks the high quality "Assam" and "hybrid" varieties more severely than the "China" and "Manipuri." In some cases "China" jat also gets badly affected. "Manipuri" may remain immune in some localities and may get as badly affected as the "Assam" in others.

The appearance of the disease as an epidemic appears to be regulated by climatic conditions. In Assam when the disease has established itself for many years, the blight appears quite suddenly, kills off new shoots and leaves and the bushes gradually recover. One year it spreads with remarkable rapidity over a garden and the next year may be entirely absent.

How blister blight got established on tea in India is not known; the probability is that it lives all the year round on tea only, as *Exobasidium vexans*, so far, has not been found on any other plant in India. Spores of the fungus are distributed by the wind and the disease is severe on slopes exposed to the wind. Coolies while plucking leaf may carry infection in their clothes. The disease is also most probably introduced into unaffected areas with the seed or the earth in which it is usually packed.

The loss sustained to tea owing to this disease may be gauged by the following example: In 3 gardens in India comprising about 1,300 acres of tea, the blistered leaves gathered and destroyed in two seasons amounted to 903 maunds and $\frac{1}{6}$ of this represented loss of leaf that would have produced tea, i.e., about $37\frac{1}{2}$ maunds (3000 lb.) of manufactured tea. The cost of collecting the blistered leaves amounted to Rs. 657, which also represented loss.

Methods that have been adopted for combating the disease are (1) Picking off diseased material, (2) Pruning, (3) Spraying with fungicides. The first and second aim at lessening the spread of the disease by destroying the material which carry infection. The third aims at killing the fungus and at preventing the growth of spores that may fall on sprayed leaves. The first method is only practicable late in the season after good growth has been made as it would be dangerous to the bushes after unfavourable growth early in the season. Another drawback is the strong labour force required. As it is likely that unpruned tea carries the disease from the end of one season to the beginning of the next it is recommended that in cold weather no tea be left unpruned. As heavy pruning may reduce the vitality of the bush to withstand a subsequent attack, cutting back must be done with caution when an outbreak may be expected. Spraying is difficult. It is on the lower surface of the leaf that the spray has to fall on and during wet weather the fungicide is washed off. On heavy pruned tea, new extensions, and seed beds spraying could be carried out with a certain amount of success. The fungicide used is Bordeaux mixture.

COFFEE.

GRAFTING IN COFFEE CULTURE.*

DR. P. J. S. CRAMER.

(Translated from the Nederlandsch-Indisch Rubber-en Thee Tijdschrift 1923, Nos. 18, 19 and 20, by H. L. Ludowyk, Librarian, Department of Agriculture, Ceylon.)

BRIEF HISTORY.

The title I originally intended giving to my discourse of to-day was this: "A New Development in the Cultivation of Coffee." But I feared, however, that, when it was noticed that the new development referred to by me was grafting, many of you would protest that it was no novelty at all.

More than two decades have elapsed since such planters as REIMSDIJK on Klein Getas, BUTIN SCHAAP on Kandangan, and EVERARD on Kaiwisari grafted coffee and established large coffee plantations, every tree of which was grafted. Before this both Arabian and Liberian Coffee grew in Java in their original state as in their natural home. All this is perfectly true; grafting in itself is nothing new in coffee cultivation. And when I deal particularly with the graft, the method of carrying out the process of grafting and such like points, I am certain that, to most of you, I shall be serving up old matter though supplemented and garnished here and there, by some new data. This, however, is not the aim of the discourse I have in view. My chief aim is to discuss the subject of grafting from a point of view that is quite different from any view-point so far taken. I have in mind particularly to make people realise that these methods discussed by me can produce better results than those hitherto obtained.

The prospects of the coffee industry seem to assume for us a changed aspect; a new vista, bright and hopeful, with fair possibilities for enhancing the out-put, and for the better protection of plants from disease, stretches before us.

BUTIN SCHAAP'S GRAFT.

In the past when people had recourse to grafting they had three different purposes in view. The earliest experiments were undertaken in order to protect the then generally preferred Arabian Coffee from eelworms which infested Arabian plants raised on the same stock. The example of the grafting of the European grape vine on the American varieties in order to withstand the grape louse was adopted for coffee. The pioneer in this work was the Administrateur of Kandangan Estate, BUTIN SCHAAP who grafted the Margogipe (variety a variety of Arabian Coffee) on a Liberian stock. Later, another famous planter, KRIJTHE again grafted Arabian coffee

* Address to the Kederische Agricultural Union at its meeting of Nov. 24, 1923, at Blitar, as an introduction to an excursion to be made to the Government Coffee Seed Station, at Bangelan.

The impromptu speech is here annotated and furnished with data regarding the experiments at Bangelan, which were not then available.

on Liberian stocks according to a different method, that of Splice Grafting. Grafting of Arabian Coffee was even at the very beginning found impracticable as success was very uncertain, and, even if the graft was successful, Arabian plants over a different stock became rather an unreliable producer.

THE KLEIN GETAS GRAFT.

The second aim of the experiments in grafting was to propagate desirable types of plants which were difficult to obtain under ordinary cultivation. I shall now bring before you from the history of coffee cultivation the Klein Getas Graft, as it was generally called, and indicate certain particulars which were pointed out to me by certain planters of Central Java. In 1889 the then Administrator of the coffee estate of Kalinas found among his beds of Liberian plants an exceptionally robust plant. Whereupon it was immediately supposed that the plant in question was a hybrid between Liberian as mother and Arabian coffee as male, for those were the only two types that were then planted in Java. The man who discovered this plant took quite a fancy to it, and as it was a plant that greatly interested him, he planted the hybrid carefully near the dwellings of some employees on the estate. After the course of two years the first berries appeared. They were very carefully gathered and used as seed. No one had access to the treasured new plant which was going to make its owner rich indeed. The Superintendent of an adjoining estate, having been unsuccessful in his effort to obtain any seed of the coveted tree, managed to secure for himself only two branches. He took these to his estate Klein Getas, tried an experiment in grafting them on plants on his beds and succeeded. Thus came about the first instance when a coffee branch was grafted on a plant. The grafted plants were planted out and by further grafting more such graft-hybrids were propagated and very soon these found their way out of Klein Getas to other parts of Central Java and East Java, where some specimens, which were brought over and planted so long ago, are yet to be found.

REIMSDIJK in this case made use of the process of grafting for the purpose of having an estate planted within a short period with plants of the Kalimas hybrid.

The owner of the discovered hybrid, DESSAUVAGIE, planted out his seed. But they did not grow true, as experience in seed propagation generally shows, and gave rise to inferior types which, with regard to the harvest produced, were very much behind those hybrids his neighbour obtained by grafting. Although it was effected with the aid of the newly discovered Kalymas hybrid, when men, by general consent, for many succeeding years, continued to call the graft the Klein Getas Graft, they were, even unconsciously, paying a tribute to the man who did a great service to the coffee industry, not by the discovery of a mere chance hybrid, but by keen perception and insight into the great possibilities the hybrid would have for practical purposes if properly experimented upon and with success; and this vision culminating in the introduction of a method of grafting then altogether unknown formed a wealthy contribution indeed to coffee cultivation.

THE KAWISARI GRAFT.

And now we pass to the third aim to effect which grafting is resorted to: The method used for this purpose was resorted to first on Kawisari. The aim in the first place was to convert certain old Liberian trees, which produced but very poorly, into hybrids that perform their functions of

production in an appreciable degree. The attention and observation of the experimenting planter, aided by chance, helped again in the discovery of something valuable. Among a number of Liberian seedlings of his sowing, HEER EVERARD discovered some very fine remarkable specimens of plants. These he labelled with the letters A. B. C. and D. in order to differentiate and identify them from one another. Soon the plants marked B. and D. began to develop in such a way as entirely to give satisfaction. The nature of the leaf which bore certain characteristics of Arabian coffee, in addition to others of its own, at once helped to corroborate the supposition that it was a hybrid. Then experiments were conducted with the old and poorly producing Liberian trees. Two offshoots were put forth. The cleft grafting of one of the offshoots of the hybrid on the old roots was successful, and, with all the appearance and the true characteristic of a well grafted tree, it produced very satisfactorily. Thus the Liberian plants which were not of any account as producers were practically regenerated by grafting into heavy producers. Afterwards, encouraged by these successes the breeding of graft-hybrids on nursery beds was largely undertaken and in this manner HEER WILLEMSE brought under cultivation several hundreds of bouws of heavily producing coffee plants grafted with both the specimens of the Kawisari hybrid which are mentioned above.

A great advantage that the system of Kawisari grafting possessed was that, from the beginning, offshoots were used, and not, as in the case of the Klein Getas method, branches. This advantage was in a great measure responsible for the wider popularity of the Kawisari hybrid and the generally acknowledged superiority of the Kawisari grafting method over all others; and it is certainly noticeable, even in a cursory survey, that this is the most popular hybrid.

For the sake of completeness I may also mention here that the Nestor of Coffee planters, HEER OTTOLANDER, has also planted at Pantjoer a very large estate of grafted hybrids. These plants on his estate were made up of a collection of various types and varieties which were in a curious manner brought together to make up a complete plantation of a complexity of specimens.

This is but a short sketch of the history of the introduction of grafting to coffee culture. Here we should also express our great esteem for, and indebtedness to, the worthy old planters who helped in a great measure to put the methods of grafting into practical use.

GRAFTING OF HYBRIDS.

I will bring before you two points from the history of coffee grafting. In the first place the grafting of hybrids alone has been adopted on somewhat a large scale. There are two reasons for this occurrence. As we shall see somewhat later, the hybrids of coffee are specially suited for the purposes of grafting; growth and splicing take place fast and conveniently The second reason for their preference for grafting is due to the fact that, generally, hybrids cannot be propagated by seed except with very disappointing results. People could therefore have recourse to grafting in order to plant up an estate with hybrid plants that can bear heavily.

The second fact that I want to bring up to your notice is that grafting was resorted to only through constraint. It was adopted in no way by choice but simply because it was the only possible means in certain cases to the attainment of the aim in view for bringing under cultivation a fair and suitable plantation of coffee.

With these remarks we bring to a close our brief review of the history of coffee grafting. In the decade that saw the application and practice of the methods newly devised, an important and valuable fund of experience must have been gained, undoubtedly : in the first place, the methods have been so much improved that grafting presents, or, in any case, should present, no difficulty. Cleft-grafting of seedlings or of offshoots of old stumps, on beds, or *in situ* on the estate respectively, is, I think, the generally adopted process as it is considered the easiest and the surest.

GRAFT HYBRIDS COMPARED WITH ROBUSTA.

But grafting has not spread as it might have been expected to during the period 1900-1910 when both Arabian and Liberia coffee abandoned us. It can in no way be attributed to the want of knowledge and information regarding it. I may here help you to recall to your minds that I myself many times championed the cause of grafting. At the Ninth (9th) Coffee Congress of the 13th and 14th December 1907 held at Soerabaja, I emphasised the fact that measures should be adopted in order to arrest the deterioration that was manifest in Liberian coffee, and I stated in conclusion that we should go back to planting new varieties. I advised not only the adoption of Robusta, but also recommended hybrids. The twelfth point of my conclusions ran thus : "It is not probable that plantations of the above mentioned hybrids (Kalimas and Kawisari hybrids) will be attacked to any serious extent by the leaf disease. In land below 2.000 feet altitude, and even at higher elevations. with a satisfactory rainfall their cultivation will be found to be profitable. In this lies the recommendation that in addition to Robusta, large plantations of graft hybrids should also be laid out." In 1919 in the 'Indische Mercurr' of 19th July, I took up the question again. I discussed which should be given the preference, Robusta coffee or the graft hybrids.

Although Robusta was known to possess several advantages, when the case for both was summed up, it was seen that there were some points in which the hybrids scored and showed themselves far superior to Robusta. And I deducing from this, recommended that graft-hybrids should be widely planted in addition to Robusta as these graft-hybrids would serve as a good reserve stock which would every year afford an appreciable, although not a very abnormally great, harvest. This advice had very little effect. Robusta was so easily raised, as it had only to be propagated by the sowing of seed, it produced so very copiously, and people were so much taken up with the new variety, that very little attention was paid to the graft-hybrid which was not so easily propagated. And as it happens so often in agriculture here was *le bien ennemi du mieux.*

GENERAL APPROBATION OF GRAFTING.

The fact, that, for the thousands and the quickly spreading tens of thousands of bouws of Robusta, there were planted only some hundreds or at most two thousand bouws of the graft-hybrids, at once arrests our attention ; and the reason for this preference of Robusta, which is not difficult

to find, becomes clear. Grafting has but to a slight degree won the approval of planters as it is more difficult than mere sowing; the grafted plants require more attention from the planters than that generally paid to others, and further, a large stock of planting material requires a fair length of time and a good amount of labour to propagate. Especially when a large piece of land has to be opened up and planted with coffee in a short space of time, grafting of plants offers almost insurmountable difficulty. The question is often asked why planters, nearly always, when planting out an estate, merely use seedlings and why they but seldom, only by way of an exception, use grafted plants. The answer is simply this: the first method is the easier.

Grafting requires rather great skill on the part of the planter. In the first place he should be careful to see that a good number of stocks are ready on the beds for grafting. If grafting is to be done on a large scale then the necessary measures should be adopted in time: for example, if a large tract of land is to be planted with grafted trees at the end of 1924, then the seed for propagating the stocks should already have been sown in the germinating beds in September 1923, so that by November of the same year the seedlings can be transplanted in the nursery beds. Then at about the time of the next west monsoon the grafting can take place. The necessary tubes have to be procured and kept ready. The necessary number of scions that are suitable for grafting on the stocks have also to be kept in readiness. Above all, there should be two men very well trained in the processes of grafting, for doing this work alone. The last mentioned requirement seems very often difficult to procure. In order to overcome this difficulty I wish to remind you that aspirant grafters can always be trained in this work for private estates at Coffee Experiment Station at Bangelan.

What I have stated above is quite enough to make it clear to all planters that if grafting is to be resorted to on a large scale on estates, the necessary steps for it should be taken over a year in advance.

When I returned to Java after an absence of some years and continued to take an interest in coffee cultivation, I was in 1914 given in charge of the Coffee Experiment Station at Bangelan, and there I set about working on the problem of grafting in order to resuscitate interest in it.

At the outset I felt keenly conscious of the great difficulties of which I have spoken before. They were not insurmountable but made us realise that bringing into bearing a plantation of grafted coffee trees was not plain sailing as we have thought, and that a fair number of years would have to pass before we saw the culmination of our labours. The Administrator of Bangelan, HEER BOOM, was the man who laid the foundation upon which his successor HEER GEISSLER worked; and HEER PARKINSON completed the work. HEER PARKINSON, who is to the present time conducting the operations at Bangelan, will certainly lay out in the course of a few years yet a great number of valuable plots planted with grafted trees.

Before I give you an account of the experience gained by the grafting done at the Coffee Experiment Station at Bangelan, or even before I give in outline an account of the experiments themselves which we shall inspect to-morrow, I wish to set out before you the essential points of difference between the aims we have in view to attain by grafting, and the aims of

those (BUTIN SCHAAP, REIMSDIJK and others) who introduced the systems of grafting which were summed up by me before. As we have already mentioned, grafting was formerly resorted to when the improvement of plants by seed selection alone was not possible ; Liberian coffee was grafted in order to overcome the attacks of the eelworm pest, and partly to overhaul certain old Liberian stumps ; always, as these instances show, forced by necessity, to achieve certain aims, but never because grafting was given the preference as the more effectual method of plant improvement.

When we began the experiments in grafting at Bangelan, no real immediate necessity ; no compelling circumstance of a pest to counteract, or suchlike causes as above spoken of, narrowed down our aims. The experiments were undertaken purely and simply, because grafting, in itself a far-reaching study, seemed a sure and worthy means of raising the standard of our coffee cultivations.

In order to get some enlightenment from the experience of others in this matter we should direct our attention not to what the history of coffee cultivation alone affords, but we should far rather take lessons from the other industries of different climes which have reached a higher stage of development and for which grafting helped to achieve, centuries ago, practical results to their benefit. So much was grafting resorted to that no one would attempt, for instance, to plant up an orchard or a vineyard that is to be of any repute with plain seedlings. The fact that good fruit trees are planted only after grafting speaks of itself in favour of this process. The value of grafting in agriculture is decisively acknowledged and experiments and research with regard to it tend merely to find out which are the best stocks to graft upon and what improvements can be achieved in plants by the selection of scion and stock, and such like issues. For this reason we find ourselves more and more engaged in studying the various applications for vegetative propagation that are resorted to in Tropical Agriculture.

The opening of a station in the Lampongs for work in the selection of permanent crops, together with my endeavours at Bangelan, has enabled me to direct the work and the experiments in this station in the direction of vegetative propagation of our principal industrial plants. Now, in a short time, the advantages gained by the direct bearing the work of each of these establishments has on that of the other will entirely be lost and opportunities for valuable experimentation will greatly be curtailed by the abolishing of the Experiment Station in the Lampongs. I wish now to express fully and frankly the great importance I attach to a good as well-staffed permanent experimental establishment for conducting experiments in grafting. In the last ten years we have done continuous experimental work on many different crops ; and, basing the statement on the conclusions drawn from those experiments, I can make bold to say that I consider grafting the best method to adopt in order to make our permanent crops more flourishing. I will not dare to say that the path to success by it has been established or that each one who takes to it will be successful. No, the way has yet to be firmly established ; there is a number of difficulties that have to be overcome ; but we have to admit that the faint trace of what might be the path exists.

Many years have passed since we began our experiments and investigations in grafting. The reason for the very scanty information and even the absence of it with regard to our work which the general public possesses may be explained by the fact that the progress of these experiments is so very slow, each taking some years to complete. In order to be more clearly impressed we should turn our attention to other countries. In Europe, already very long ago, grafting was well established and generally resorted to. The wideness of its application in fruit culture can be judged from the fact that it would have been a cause for great surprise if a man attempted to plant out an orchard, a vineyard or a citrus plantation without grafted plants. If there is another country which lends itself well to compare with ours it is America. In America for centuries the propagation of fruit plants had been carried on only by means of seed, till two great supporters of grafting advocated its cause and encouraged people to graft their plants with good varieties introduced from Europe. They had not to work long, for soon the superior value of grafting was established ; and the method is now generally adopted except, perhaps, in the cultivation of citrus fruits which industry is rather tardy in taking it on.

Modern methods of cultivation recommend propagation to be carried on by means of grafting exclusively.

It is really instructive to trace the history of a branch of fruit cultivation in America. We shall take for example the cultivation of peaches, one of the most important fruits in the United States. We notice that the first planting of grafted trees does not date back relatively to very distant years. The first introduction of grafting in this line of fruit cultivation occurred about a century ago and it came to be adopted largely about the year 1850, not before. I shall here recount certain points of special interest from a work of PROF. HENDRICK who produced a series of remarkably complete and finely illustrated monographs of the most important kinds of fruits of the State of New York. In this series, among other fruits, he deals with peaches. The book entitled THE PEACHES OF NEW YORK appeared in 1917. The following passage is extracted from the work. "Towards the end of the eighteenth century the sowing of peach kernels heralded the system of grafting. It is not definitely known who in the UNITED STATES began grafting. The desirability of obtaining grafted plant-material was recognised and spoken of already in 1736. An English botanist, PETER COLLINSON, followed and supported by his American colleague JOHN BARTRAM, urged the grafting of plums and nectarines on stocks of peach trees. Apparently this question had been considered before the time we are speaking of, for COLLINSON writes to BARTRAM, 'Now, try it for once, for I have a firm conviction that it will succeed.' It was difficult to convince BARTRAM ; but even ten years later COLLINSON is seen busy trying to spur him on to follow the course he advised him to take. In a letter dated 26th April, 1746 he writes with a certain amount of impatience, 'Although you are unable to perceive it, I have, however, told you what can be achieved by the grafting of the peach tree as stock'.

Apparently, peaches were first grafted in America by PRINCE and his pioneers at the nurseries at Flushing in Long Island, for in their Catalogue of 1771 they include twenty-nine varieties ; but most of them appear to

have been different types rather than varieties. Twenty years later they placed on their list thirty-five varieties and stated, in addition, that all were 'inoculated,' meaning that they were brought into existence by grafting. JOHN KENRICK, who for many years was the most celebrated of PRINCE'S colleagues, and who had his nurseries at Newton, Massachusets, began his work in 1790 with a number of peach kernels. The trees he obtained by sowing these he did not graft. Four years later, as it has been communicated to us, he came to be acquainted with grafting and he resorted to breeding on a large scale with his collection of varieties. And by this means he made a speciality of grafted peach trees.

Until the middle of the last century, in spite of all this work done in grafting, peaches were generally propagated by means of kernels. The land between the coast of Atlantic Ocean and the Missisippi in the half century that followed the Civil War, was in a short time colonised and in nearly every farm between the Great Lakes on the North and the Gulf of Mexico on the South, except one strip in the extreme north of this region, peaches were planted. The products of these great resources of peaches served not only as food for men, but were also used for fattening pigs ; and these fruits, in addition to apples, then formed one of the chief sources for the alcoholic beverages which the peasants of that country always had in stock for their daily consumption. There were millions of peach trees in America before the year 1825, but until that time there were very few varieties identified. Then the knowledge of grafting began to spread : nurseries seemed to rise from the ground as if by magic ; the large and varied collections of peach varieties were well sifted and subjected to selection. Local varieties were soon established, and when the means of communication were better developed, the new varieties started on their spreading advance, until in 1860, in the different nurseries, more than 400 different varieties were enumerated, a number that at the end of the century was so augmented as to reach the thousand."

I will yet, once more, emphasise the importance of the fact that the elimination of seedlings by the introduction of grafted plants must take place. The necessity for the replacing of the old means of propagation is not so necessary in the case of the peach, for the characteristics of its different varieties are fairly well preserved when propagated by seed. But no one will, however, plant an orchard of peach trees with seedlings. The figures given below show that in California alone 7,800,000 grafted peach trees were in bearing, and 4,400,000 belonged to young and undeveloped plantations. These figures give us a clear example of how much can be done in the way of grafting. If other examples are required they are not wanting. I shall quote them for your edification : all the lemons consumed in Europe, most of which come from Italy, are those picked from grafted trees : in that country (Italy) there were in the beginning of this century no less than eight million grafted lemon trees in bearing. In Southern France there were in 1895 nearly 600,000 Hectares planted with grafted Vines. This area is about four times as great as that of all our coffee cultivation (in the Dutch East Indies). When we have such striking figures brought before us, we naturally ask ourselves the question if ever the time will come when all the coffee beans—at least the coffee raised in the estates of the Dutch East Indies—will be picked from grafted trees.

GRAFTING EXPERIMENTS AT BANGELAN STATION.

When, in 1914, I was first connected with the Experiment Station at Bangelan, at the very initiative, when drawing up the programme of work to be done, I gave to grafting the foremost importance in my Scheme. We made a departure from the standpoint from which, up to this time, grafting was considered ; we no longer looked upon grafting as a method of propagation adopted only when the use of seedlings was not practicable ; no, we placed it, on the other hand, on the foreground in order to establish it as the means for improving our plantations and lowering the cost of production, not as the means we were driven to by resource, but the one we adopted by choice.

The most important item then of the programme drawn up for Bangelan in 1915 was the study of grafting.

With regard to the grafting experiments I made a note in it to this effect: "The considerably greater portion of our work in Bangelan should be directed in the way of grafting. Plantations of grafted plants which should be directly descended from superior parent trees should be established. These plants will derive from the parents their valuable characteristics. With the aid of these grafted plants which will be distributed to estates attempts can be made by planters to improve their cultivations."

"If as a result of the work of Bangelan they induce people cultivating coffee to follow in our footsteps, the Experiment Station will be doing for the industry what at the present time is of the greatest importance both to the estates situated in the highlands as well as those on the low country.

"The system is simple enough. We bring into our collection as many different kinds as possible. Those which, either by their appearance or by reason of the reputation they bear on the plantation, recommend themselves to as being the best, we ameliorate by grafting. All inconsistent types being eliminated, our plantation of grafted plants shall always be uniform and preserve its characteristics.

"The difficulty of all this lies in the execution."

In 1913 I also gave an explanation of both the methods of grafting that ought to be tried : grafting while the young plants were in their nursery beds, and grafting on the open field.

In the programme of work for 1915 I wrote : "A second method of grafting is carried out on the beds and Excelsa is preferably used as stock. If the necessary number of suitable scions are obtained, by grafting on beds, planting-material for distributing on the estate can be conveniently cultivated. Before we advance so far, a period of time certainly not less than one year and perhaps less than three years will have passed.

"While the field grafting goes on it will be very advisable, by way of exception, to bring well under cultivation a good plot of practically important hybrids such as the Kawisari hybrids B and D., and also the Kalimas hybrid. In 1916 one or two bouws of each of these hybrids should be planted in order that they serve for experimental purposes and also to demonstrate practically the great value of these hybrids.

"For laying out the plots for the graft-hybrids, the sloping parts of the land towards the north, between Old and New Bangelan, can be used ; it has been reckoned that there will be ample room for the purpose even for spreading after the trees have developed.

"With regard to the records and the books that are kept regarding the experiments done I may mention that there is a field book in which all the plots are represented and where annually entries are made of the grafts that have been successfully effected ; the grafts done on the beds are recorded in the special book. The plots that are occupied by plants that have been grafted on beds and transferred later are naturally entered on the field book."

In the same programme of work the transformation of the old plots by means of grafting is also described as follows :—

There is a number of plots at Bangelan containing plants which are a mixture of types although they are all descended from one parent tree. Their only value is for what precarious crop they might provide, and there seems to be hardly any use in letting them remain as they are. The plants in these plots should all be cut down to the stem and the off-shoots then arising should be grafted. Each plot which was about ½ a bouw in area, was grafted with scions from one parent tree, and we thus obtained, at length, a number of good plots of some uniformity from a heterogeneous collection.

This reformation can also be effected gradually so that the loss resulting from the crop that one has to forego is so minimised as to be neglected Every year the bad yielders should be cut and grafted ; the trees that are good can also be cut and grafted gradually. In the course of a few years the whole patch will contain only uniform grafted trees.

In the years 1915 and 1916, with the co-operation of the administrateur, I inspected each and every plot and made a list of those that were noticed by us to be badly in want of grafting. A beginning has been made by cutting and grafting the trees on these plots. But records should be kept for each of these plots, or rather a plan of each with the trees on them, to show which trees have been grafted and what kind of scion was used on it.

GRAFTING ON BEDS.

The experiments on Bangelan were forthwith carried on in two entirely different branches. In the first case a series of small plots was laid out, and the plants of each was descended from a parent tree of ours which was selected after noticing for a long time its capacity for production. These square plots are very small and have only sixteen grafted plants in each, planted in four rows of four trees to a row. So we obtain a field of unique appearance, like a chess board, divided up into small squares, each of which contains sixteen grafted plants of one parent tree. This is, as it were, a pattern of all our parent trees, a living museum wherein all our superior material is collected together. It is therefore called 'de Museumtuin,' the museum garden. The laying out and establishing of this field took place at the end of 1916, the beginning of 1917 and the beginning of 1918.

A second field of grafted plants consists of plots somewhat larger than those in 'de Museumtuin' and each plot has seven rows with seven plants to each row. These are called group plots. They were laid out and planted primarily for this purpose : by quickly improving the grafted plants on the smaller plots, to obtain material for spreading the cultivated plots so that, in time, the offsprings of each parent plant occupied the area of one Hectare. The somewhat larger group gardens serve remarkably to emphasise and drive home the already existing impression of the importance of the parent trees. The laying out of this group garden was begun at the beginning of 1918.

Lastly, the third lot of this series of plots that I have to mention is the 'hectaretuin.' Every one of these plots occupies the area of one hectare which is fully planted with grafted plants of one parent tree. Each of these is surrounded by a border patch of even breadth which is also planted with grafted trees all of another one parent tree. These plots were brought under cultivation in the beginning of 1918 and 1920 and are at

present in production. This is the series of plots to which Bangelan has recourse for the supply of grafts on a large scale. In the past few years all the plots of grafted coffee, both the large and the small plots, yielded a regular harvest from the time the trees came into bearing. The records of the crops have been kept and afford us a deal of very interesting data regarding the productivity of grafted plants. These are the total numbers of the plots on the Station.

250 'Museumtuinen,' plots with 16 grafted plants to a plot, planted at the end of 1916 and 1917.

139 'Groeptuinen,' plots with 49-98 grafted plants to each plot, planted at the end of 1917.

30 'Hectare,' plots with 1100-1600 grafted plants to each plot, planted at the end of 1918 and 1919.

15 Border plots planted at the end of 1918.

FIELD GRAFTING.

Besides these experiments which were carried on on plot beds, there was a number of grafting experiments carried out on old trees which were cut down to a stump. For the purpose of these experiments twenty plots which for some unknown reason had been set apart for the purpose of procuring seed as planting material were used. There was some fear that the heterogeneity of the collection of types on these plots would, if the plants were used as seed-bearers, help in the spread of irregular plantations. If these plots were to be entirely re-planted we would have needed more grafted plants than we could afford. So another plan was adopted to remedy them. A row of trees of these plots was cut down as far as the stem and the offshoots on these were grafted with scions from our collection of parent trees. In this manner the work was steadily continued, starting from the North West of the field. At the end of 1915 a series of twenty plots were thus experimented upon. In this manner the field on which the grafting was carried on was thoroughly changed and reformed into an uniform collection of grafted plants derived from one parent tree. The field was also rendered a good deal more productive than it was. There are points about this method of grafting that recommend themselves to planters and even lead them to think it the preferable method. There are points too that are prejudicial to its adoption, for example, the more difficult control. For us, however, this method of grafting in the field was great importance and had its favourable side. Several different sorts of stocks had to be used in grafting these plots, and in the first years, during the course of these operations, we had a good deal of experience with regard to the most important issue in grafting—the relative values of the stocks used and the success obtained with them.

We have here summed up briefly the account of the experiment at Bangelan. As it is generally known, from 1915 onwards research has been diligently carried on at the Bangelan Experiment Station in grafting. We have brought to bear on these experiments all our experience, and we may have had to suspend one experiment for results to be obtained from another which we had to start, we may also certainly, on many occasions, have groped in the dark ; but this must occur in experimentation, and I feel confident that in a short time it will appear clearly to all that the results of our experiments will make the coffee industry turn the corner that will lead it to a highly desired state of success. It should not be forgotten that criticism is easier than a well-founded statement regarding a probable occurrence in the future ; and grafting on a large scale in coffee culture was placed on quite a different foundation by the experiments conducted at Bangelan.

OILS.

SOME UNCULTIVATED OIL YIELDING TREES AND PLANTS.

W. MOLEGODE,

Agricultural Instructor.

We have many uncultivated trees and plants from the seeds of which oil is extracted for various uses. A few of them are dealt with in the following article. Of these some are obtainable in fair quantities and the production of larger quantities could be easily encouraged in the rural districts if purchasing agencies are to be established.

Kohomba, Kekuna, and Mee are well known village oils, Eriya, Domba and Duhudu are obtainable in limited quantities. The others mentioned in the list are extracted as required. The following oils and oil-seeds were included in the collection of miscellaneous agricultural products recently sent to the British Empire Exhibition, viz :—Kohomba, Kekuna, Mee Domba, Duhudu and Dorana.

Kohomba : Margosa, *Azadirachta Indica.*—A very valuable tree, almost every part of it is utilised in some form or other in native medicines. It is a very large handsome dry zone tree with brownish red bark and crowded leaves. The wood is now largely used for cabinet making. It is a hard, heavy wood of a red brown colour, large graining and takes a magnificent polish. In some parts of the Island it is a cultivated tree. In the Kandy district it is often met with in village gardens having been carefully grown for medicinal requirements.

The oil extracted from the seed is highly valued for its medicinal properties both by the Sinhalese and Tamils. The seeds yield about 15 per cent. of oil of a very strong disagreeable odour and bitter taste. It is used in various diseases both internally and externally. As an anthelmintic and antiseptic it is much in use.

A full grown tree will bear heavy crops. The oil is rather costly—a quart bottle is sold in Kandy at Rs. 1·50.

Kekuna : The Candlenut, *Aleurites triloba.*—The tree grows luxuriantly in the Kandy district and elevations up to about 2,500 ft. above sea level. It is a quick growing tree and begins to bear in 3 or 4 years. Under favourable conditions such as a protected situation and moist soil it is a very prolific bearer yielding many thousands of fruit. The hard shelled seed contains the kernel yielding on pressure over 50 per cent. of oil which is easily extracted by simple methods by the villager and is employed largely in the rural districts as a lamp oil. Its commercial possibility lies in it being a good lubricating and soap-making oil and possibly for making varnishes.

Until recently Kekuna was very common and a fairly large quantity of oil was in use in the villages. The use of Kekuna wood for making tea boxes caused the felling of the tree to a large extent; but as this wood has now been condemned as a suitable chest there is the possibility of a trade in Kekuna oil being started more specially as soap factories are being established in the country.

Good clear Kekuna oil could be bought at about Rs. 1·50 per gallon. A bushel of seed would give about 2 gallons of oil and some times a single tree gives five or more bushels of Kekuna nuts.

Mee: *Bassia longifolia.*—A common tree both in the wet and dry districts. Attains to a great size. Affords a very hard, heavy and durable wood.

The seed yields a large amount of an edible oil still largely used in the villages in cooking and preparation of native cakes. It is reported to possess valuable medicinal properties and is commonly used in pains arising from rheumatism. It is one of the compounds of the *Pas-tèl* (five oils) so valued as an application in sprains and other rheumatic pains.

A fairly large amount of oil is produced in villages for home use. This oil has not entered the market yet. It is a cheap oil—a bottle sells in the villages at about 30 cts.

Domba—Calophyllum Inophyllum.—This is commonly referred to as the Alexandrian Laurel. A moderate sized tree common in the low-country chiefly on the sea coast. Affords a useful wood which is much favoured for cart poles.

The seed yields a high percentage of a fixed non-edible oil used largely as a varnish and medicinally for external application for rheumatism.

Duhudu—Celastrus paniculatus.—The seed of this large climbing shrub yields a valuable oil of a very bitter nature reputed to be a nerve tonic and a brain stimulant. It is also used externally for sores and skin affections. The bark of the creeper is also used medicinally.

The Duhudu creeper is confined to a limited area and is frequently met in the moist part of Ratnapura and Upper Uva. It is a prolific bearer and the small red angular seed yields 40-50 per cent. of a dark red thick oil.

Kina—Calophyllum tomentosum.—A large tree common in medium elevations. A well-known and favourite wood.

The seeds yield a valuable oil which is used in cutaneous diseases of all kinds and is specially good for itch.

Na—Iron wood—*Mesua ferrea.*—A prominent tree around temples grown for its sweet scented flowers and the beautiful red coloured young leaves used at religious ceremonies.

The seeds yield a fixed oil of a deep yellow or brown colour extremely bitter in taste. It is used as an application for cutaneous affections and as an illuminant. The percentage of oil in the Na kernel is very high and exceeds 65.

Iriya—Myristica Irya.—A tall slender tree. Easily recognised by the large clusters of reddish brown fruits.

The seeds yield a popular lamp oil.

Karanda—Pongamia glabra.—A common tree specially on the banks of streams and rivers.

The seeds yield a thick oil of a bitter taste used in skin diseases.

Telambu—Sterculia foetida.—The Telembu tree is easily distinguished by the strong offensive smell of its flowers or by the large dull red or orange coloured woody fruits with its black seeds. The seed itself is eaten roasted and has a pleasant taste. It yields a good proportion of oil of a bland non-drying nature. The oil is edible and is also used for burning and should find a market among soap makers.

Dorana—Dipterocarpus glandulosus.—Dorana oil is obtained by burning charcoal in cavities cut in the stem of the tree. This is a well-known industrial oil used for mixing paints and as a varnish. It is also of medicinal value.

A fair amount of the oil is produced in the Southern Province.

Munamal—Mimusops Elengi.—A very large tree. Occasionally cultivated for its fragrant flowers and the bark which is used medicinally.

The seed yields a fatty oil of a very bitter taste.

Makulu—Hydnocarpus venanata.—A common tree growing by the side of rivers and streams. The fruits are poisonous and used as a fish-poison. The seed yields an oil which is used in the treatment of skin diseases.

Madol—Garcinia echinocarpa.—A common tree easily recognised by many long ærial roots near the ground.

The seeds yield an oil used for illuminating.

Kon—Ceylon Oak—Schleichera trijuga.—A very large tree common up to about 2,000 feet and yielding abundant crops of fruits.

The seeds contain a very high percentage of a fatty oil so well-known as Macassar oil much valued as a hair oil.

Rankirigokatu—Argemone mexicana.—This plant can be recognised by the variegated green and white prickly leaves and bright yellow flowers.

The seeds yield an oil which is employed by chitra workers.

Weta enderu—Physic nut—*Jatropha Curcas.*—An excellent hedge plant; will grow under the most adverse conditions.

The seeds yield an oil with drastic purgative properties. Externally it is applied in itch and eczema. It should be good soap-making oil.

Kaju—Cashew nut—*Anacardium occidentale.*—The kernels—the cashew nut—yield a light bland oil. The pericarp or shell yields a black acid and powerfully vesicating oil.

Pènela—Soap nut tree—*Sapindus emarginatus.*—The fruit is used for soap. The seed yields a semi-solid oil used as a substitute for soap.

SOILS AND MANURES.

SOIL SURVEYS.

THEIR IMPORTANCE AND ADVANTAGES, AND RELATION TO SOIL ANALYSES.

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1. History of Soil Maps—Relation to Geological Maps—Soil Types.
2. Functions, Objects and advantages to both the individual and the State.
3. Classification of Soils by Surveys.
4. Surveys—Methods adopted in various Countries—Practical details of Soil Surveying.
5. Reports and Maps.
6. Relation of Soil Surveys to Soil Analyses—Chemical and Physical.
7. Soil Surveys and Ceylon Crops.

Conclusion.

The practice of mapping soils was adopted and encouraged from a very early date, but the chief maps so obtained were geological and failed to show any of the superficial deposits which more than anything else affect the constitution of the "soil" as Agriculturists know it. To us the soil signifies that mixture of clay, sand, silt and stones which covers the surface of the earth to a thickness of nine inches. The layer below this is termed the "sub-soil." Later on "drift" maps were published, as distinguished from the "solid" or geological maps already referred to. These drift-maps showed the relative positions of soils which had been transported through various agencies from their original area of formation. Though these were an improvement on the "solid" maps so far as the "soil" proper was concerned, they were by no means "soil maps" as they took no account whatever of the relative fineness of the materials composing the drift. It was only comparatively recently that "soil" maps came into usage and this was chiefly due to the efforts of the United States Department of Agriculture Soil Bureau, which has carried out a very extensive soil survey in the U.S.A., furnishing very valuable detailed information of the various types of soils that are met with in many areas, as well as complete "Soil" maps of the different areas dealt with. Since then nearly all the more important agricultural countries of the world have carried on soil surveys, the methods followed being different in the different States. In the United Kingdom, France, Germany, Belgium, and Japan systematic surveys of at least parts of the country have been made, and further progress is reported. The methods of Soil classification and Survey adopted by these countries will be dealt with later on.

It might then be asked what are Soil Maps and what is a Soil Survey? What are their functions, and their advantages? Of what use are they to the practical agriculturist? How can they be used to interpret the results

of a Soil Analysis—physical or chemical? What methods have been adopted to carry out these soil surveys? It is the purpose of this paper to answer as far as possible the questions asked. A "soil map" shows the boundaries of "types" of soil, these types being founded on a consideration of their physical and to some extent chemical characters. This brings us on to the important question of soil "types." In a Soil Survey, the unit of classification is the "Soil type," and this may be defined as an area of soil that is essentially alike with regard to texture, agency of formation and kind of material from which it was formed, and any other special properties, chiefly chemical. A consideration of each of these properties will show how it affects the soil composition. Thus from the point of view of texture soils may be clayey, gravelly, silty or sandy. The various agencies of formation, viz., weathering, glaciation, water transport and erosion, biological processes will each have a different effect on the soil constitution. Then again as regards the rock from which the soil is formed, a soil derived from a basic rock will, generally speaking, be differently constituted from one formed from an acid rock. As to special properties, soils may be calcareous when an excess of chalk occurs or peaty when there is present an excess of organic matter. Again colour and ultimate chemical composition will each go to differentiate one soil type from another. A little consideration will show that though the soils of two areas may be of the same "type," yet their crop and agricultural relations may be different, due to different climatic and temperature conditions. This is not often the case. On the other hand, the same climatic and temperature conditions on two different soils often results in the formation of the same "type." This theory of soil formation called the "genetic" theory was first formulated by the Russian Soil Worker, SIBERTZEV, and postulates that given uniform climate and temperature conditions, all areas of soil will have the same soil qualities irrespective of the rock from which each was formed. European Russia is an instance in question. As a result of climatic conditions on soil, we have "alkali" soils when the rainfall is very slight, the Black earth soils of Russia, the Lateritic soils of the Tropics, etc.

A Soil Survey is therefore a survey of the types of the soil of a district, the areas of occurrence being represented on a chart or map, different types being differently represented, and their character and chief economic and agricultural relations described in printed reports.

MR. WHITNEY, the Head of the Bureau of Soils, U.S.A. Department of Agriculture, has defined his work on Soil Surveys thus :—"Many soil maps had been prepared, but they were based upon the geology of the area and were of little or no use to the farmers. The Division of Soils believes that a classification of soils with reference to texture, structure, physiographic position, and crop relations should be made and the areas of different soils outlined in colours on maps and that this would enable a farmer or a prospective purchaser of land in the area, to determine at a glance the farming value of any tract of land." This in short expresses the main purpose of a soil survey—the correct valuation of agricultural land and its suitability to varied crops. To really render the scientific study of soils properly available for the service of the agriculturist, a general soil survey of a district is necessary.

What now are the functions of a Soil Survey ? · What are its uses and advantages ?

The functions of a soil survey are (1) the investigation of the nature and occurrence of soils in the field, and (2) the classification of soils. The occurrence of differences in the tillage and manurial requirements of soils, their crop relations, and agricultural value, makes necessary the determination of the properties of the soil that are chiefly responsible for these differences, and their arrangement into an orderly scheme of classification. The aim of the survey is to divide the land into areas of approximately the same general agricultural character.

Whilst a soil survey is useful in many ways, it is by no means a final investigation. It is chiefly a supplement to the analysis of a soil of any particular area for, by comparison with the "standard type" of the area as determined by a soil survey, valuable information relating to cultural and manurial operations of crops can be secured. It is a means of determining the status of the soil and its related conditions in the field. It throws light on many farm practices common in certain districts and may lead to their improvement.

The objects of a soil survey are described by HALL and RUSSELL thus :—

"(1) to show the distribution of soils of similar agricultural properties and to define these soils by some method of analysis—

(2) to trace such correlations as exist between the chemical and physical properties of soil, and the crops and agricultural methods associated with them—

(3) on the basis of the observed distribution of the soil types and the ascertained associations, to afford guidance as to cropping and manuring over the whole area."

Whilst of great use to the individual, it is no less useful to the State. To the individual* (1) it points out the character and location of several types of soil on his farm which may be correlated with particular crops and farm practices. Thus, for example, if a Soil Survey of Ceylon has been made, it will be possible for a prospective cultivator of virgin soil to know what crops will best suit the district he is intending to cultivate, and what cultural methods to adopt.

(2) shows him the relationship of soils over wide areas, and forms the basis for the adoption of new crops and methods of soil management.

(3) provides a reliable source of information concerning soil conditions, e. g., whether a land has to be drained, or whether it has too much chalk, etc.

(4) reveals important problems of soil improvement—as for instance whether a soil has to be limed (to counteract acidity) or otherwise manured.

(5) standardises methods of description and representation of soils.

(6) affords a guide in the selection of land for particular purposes.

The value of a soil survey to the State lies in the fact that it (1) shows its soil resources, (2) forms the basis of correlation of all other

* LYON and FIPPIN.

kinds of information, the character of which is effected by soil relations, e. g., manuring of a certain crop for certain types of soil—

(3) shows the occurrence and importance of large questions of soil improvement.

(4) gives a basis on which much of the results of experiments, investigations, and observations on soil improvements, crop growth and farm management should be applied.

(5) is a means of communication and mutual understanding between the Government institutions concerned with Agriculture and the farmer.

In brief it is an inventory of the resources of the country in land and closely allied interests.

Now that we have seen the advantages derived from a Soil Survey, it may be well to give a short account of the methods adopted in various countries, and a more detailed account of the one that is most commonly adopted, and which would suit conditions in Ceylon best. In this connection mention might be made of the various soil classifications adopted in the different countries for these have a direct bearing on the 'technique' of Soil Surveys.

The classification of soils which the farmer is generally accustomed to, divides soils into six classes—gravelly, sandy, loamy, marly, clayey and peaty. A loam contains sand and clay in equal proportions; a marl is a soil containing a fair proportion of chalk in addition to clay. Peaty soils are those in which undecayed organic matter is present to an excessive degree. Besides this there is the 'genetic' classification of soils already referred to. It is the most satisfactory general classification of soils. Attempts have also been made to classify soils on a geological basis. Vegetative features have also been adopted as a factor in soil classification, but vegetation affords information regarding the properties of a soil only when the correlation has been worked out. Further, natural vegetation is now seldom present in well settled areas. As mentioned before in many countries a soil survey has been made part of the national service for the agriculturist. The U.S.A. has given us most elaborate details of soil surveys. The work is carried out by the Federal Department of Agriculture, as well as by the individual States. Types of soil are established by the U. S. Soil Bureau for each area undertaken, the character of the crop, and native vegetation being taken into consideration. Where crops vary greatly without any marked difference in character of soil, the botanical aspect is taken as the main factor in soil classification. The name given to a soil to express its physical texture—clay, loam, etc.—is based on its average character to a depth of 24 to 30". The maps published are usually of the scale 1 inch to the mile. In Prussia and Russia the genetic classification of soils is adopted, and surveys are based on this. In France the work rests with the local authorities of each Department. The survey is made on a petrogeological or mineralogical basis. In England various methods of soil surveys are adopted, depending on the district in which it is carried out. Thus as an example of a Soil Survey based on geological formation and mode of origin we have the survey of the soils of Surrey, Sussex and Kent by HALL and RUSSEL. For a classification of soils from the genetic standpoint we have the soil of N. Wales and Scotland by HENDRICK and ORR. In the majority of cases though, the basis upon which

the soil survey is constructed, is the origin of soils, viz., geological. Each geological formation will give rise to a distinct 'type' of soil, if it has been formed *in situ*. Transport by water will give rise to two or more types.

The only classification that can be conveniently adopted is one based on the physical texture of the soil and indicated by such conventional terms as clays, loams, marls, etc.

* "The character of the information which must accompany a soil survey must largely depend on the purpose of the survey, and whether it is concerned with the agriculture of an old and settled country like England with a definite system of agriculture, or whether it deals with a new country and aims at showing the capacities of the land for crops and industries." In the U. S. the latter form of soil survey is exemplified. In Ceylon both forms are necessary. Thus the cultivation of special crops like tobacco, cotton, sugar, sisal, etc., can be extended into new districts possessing suitable soils with the minimum of risk which always attends a new venture, provided an adequate soil survey of Ceylon be carried out. Again, the suitability of land for paddy cultivation, and irrigation purposes, and the most prominent methods of land reclamation should be features in the work of a soil survey in Ceylon. Further, the recommendation of suitable methods of cultivation and manuring to secure higher yields in the already cultivated areas, are all necessary and useful information which a soil survey will provide.

The chief application of a Soil Survey in Ceylon will lie in the information it could afford as to the use of manures. The manure bills are often heavy ones, and considerable economy can be effected in this direction by a judicious system of manuring, the information so needed being furnished by the Soil Survey. At the same time the soil will be of 'good heart' i.e., in good condition and the general state of the crops vigorous and healthy.

A paper of this nature would not be complete without some account of the practical details of soil surveying. In planning a soil survey it must be remembered that the whole work is empirical. The agricultural and vegetation characteristics have first to be ascertained by field trials, and then systematised and amplified by laboratory data. Therefore the whole region must first be gone over carefully and divided up into areas with similar agricultural or vegetative characteristics. In general there will be a direct relation between the agricultural and geological areas as shown on drift maps. But as agriculture is also influenced by altitude and rainfall, contour and rainfall maps must also be used. Within each vegetative area a large number of soil samples must be taken representing the area as closely as possible. An auger is usually used in sampling, and both the soil and sub-soil are sampled. The soil should be taken from level regions, or from long gentle slopes and not on made ground, steep slopes or recently manured land. It is immaterial whether the soil sample is taken from arable or pasture land, for although the vegetation may vary yet the type may be the same. The difference of vegetation is due to differences in the compound particles as effected by cultural operations and not to the ultimate particles, which essentially constitute the soil type. Small variations in Calcium carbonate, organic matter, or water content may considerably affect the vegetative relationships of soil, although the type may be the same. The number of

*HALL.

samples to be taken will depend on the circumstances. Where the area is large and uniform, two or three samples may suffice, but in other cases local variations may be so great that a large number of samples may be taken. The depth of sampling should be 9 in. for soil, and 18 in. for sub-soil. If any marked change in soil occurs, samples should only be taken to the point where this sets in. The samples of soil and sub-soil must then be sent to the Laboratory for examination. At the same time such data as height of water table, method of cultivation of soil, suitable manures and crops, agricultural value of the land, its behaviour during drought and wet weather should be obtained. The relationship of each type of soil to natural vegetation and, cultivated plants should be observed. Information about troublesome weeds, and native vegetation, should also be obtained.

The characterisation of soil types is effected by mechanical analysis and determinations of Calcium carbonate and organic matter. Representative samples should be subject to chemical analysis. Soils about which precise information have been obtained by manurial and other trials should be very completely examined, as they would serve as standards.

The Soil Survey Report will be comprised of (1) a map of the district showing distribution of soil types. The scale should be 6 inches to the mile. Besides this in England different maps are constructed on the dot principle showing the distribution of each important crop. A dot may represent any particular area say 10 acres, the intensity of dots depending on the intensity of cultivation. The figures are obtained from the parish returns. These maps are of advantage as they show at a glance, the distribution of particular crops in any area. In Ceylon these maps can easily be constructed provided the returns are obtained from the different local Government bodies and Kachcheries.

(2) The printed Report which should include (a) the location and boundaries of the area, (b) the general physical features, (c) climatic conditions, (d) its agricultural history and development, (e) description of soils and types and (*f*) suggestions for improvement in the management of the soil—cultural, manurial and otherwise.

A further question remains to be answered—what relation is there between a soil survey and the Physical and Chemical analyses of a soil? As mentioned before, the basis of classification of a soil is its mechanical analysis. "We are not in a position to deduce the agricultural properties of a soil, either its behaviour under cultivation or manuring, or its adaptability to particular crops from its analysis, except in the roughest general fashion. For example we cannot from first principles draw up a specification of a soil for fruit growing; but by correlating the analyses of a large number of soils which have been found in practice suitable for fruit, we may find certain features in common, which in future may be taken as determining the nature of a fruit soil." So also with Rubber and Tea soils. But in these cases besides the mechanical constitution or physical structure of the soil, climatic effects play a great part.

Even on the chemical side the same is true. The significance of a given amount of Phosphoric acid say ·1 % in a soil of a given type, cannot be laid down à priori, but must be ascertained from the results from field

experiments upon the area in question. Soil analysis only reveals *one set* of factors in plant production, and these have to be interpreted in the light of local conditions such as climate, water supply and drainage. Information about these is only completely supplied by a soil survey. Mechanical analysis gives by far the most useful information in comparing soils, but this is greatly modified by the amount of chalk and organic matter in the soil. By mechanical analysis one is able to say whether the defects observed with regard to cultural growth of any particular area are due to defects of soil or situation.

The chemical work in connection with soil surveys consists, so far as the laboratory work is concerned, with the determination of organic matter and calcium carbonate in the soil. The % of Nitrogen is for most soils about 3% of the organic matter, though some of the best loams with most favourable conditions for nitrification, show on analysis but little nitrogen. The $CaCO_3$ analysis shows whether the soil is acid and needs liming. When an agricultural chemist is asked to analyse a soil he is expected to give some information about the crops to which it is suited, and the manures that must be applied. The vegetative relationships of soil are determined not solely by the nature of the soil, but by its position, sub-soil, climate, and other factors so that it is obviously impossible for the Chemist to make a satisfactory report on the sample of soil on the basis of a chemical analysis only.

"Soil analyses are limited to (1) comparisons between soils showing which are fundamentally identical and which are not, (2) tracing the correlation that exists between the crops and agricultural methods adopted and the chemical and physical properties of soil."

To do either of these satisfactorily, it is necessary to make a systematic soil survey. The problems set by the farmer to the analyst could only be answered if the analyst has an adequate knowledge of the soil type and the locality and the results of manurial or other trials on that type. He can, by ascertaining the difference between the sample and the type give the information wanted within a reasonable degree of probability; otherwise his report can only be a matter of guess work. Manures ought to be recommended as a result of experience with the different crops in the different districts, e.g., Coconuts in the Chilaw district may need a different system of manuring to that in the Southern Province. When a soil of a particular crop is sent from a particular district to an agricultural chemist, before making any recommendations he must have a fairly complete knowledge of the typical soil of the particular district from which the sample comes. This is only obtained during a soil survey from farmers or from typical field experiments that will show the effect of various manures on typical soils. The analyst must possess an adequate knowledge of the *type* if he is to properly interpret the analysis of a single sample of soil sent in by a farmer. The uses of a soil analysis may be summarised thus. It shows the farmer the defects in his soil as regards sourness, alkalinity, presence of excessive salt, stiffness, presence of plant poisons, lack of humus or of lime, poor water-holding capacity, need for drainage, imperviousness to passage of water, tendency to set hard on drying, general poverty in plant-food, excessive proportion of any soil ingredient, e.g., clay, peat, chalk or sand, and power of nitrification. In addition, it suggests to him the proper treatment his land should undergo

so as to be benefited by subsequent manuring. The determination of the amounts of nitrogen, phosphoric acid and potash *does not of itself* afford any information as to necessary manuring. This depends on the nature of the crop chiefly, and to a lesser extent, on the district and climate. Neither is it any guide to the suitability of the soil for different crops. This information can only be supplied by a systematic soil survey.

Before concluding reference must be made to the work of the kind described in the foregoing that could advantageously and with great success be done in Ceylon. Some work of this type has been undertaken in Ceylon by BRUCE who dealt with Paddy Soils and by BAMBER who reported on Tea Soils. But the ground covered by these two officers is by no means very extensive, and great deal more work on lines as started by them will have to be carried out if any good results are to accrue therefrom. Two methods could be followed :—Either a general survey of a particular district can be undertaken, say of the Western Province or a survey of all the Soils of a district under a particular crop, e.g., the paddy or coconut soils of Ceylon. In either case, for the successful accomplishment of the aims of the survey, experimental stations will have to be established in the main districts on a typical soil of this district, and manurial, cultural and varietal experiments tried. As a result of these, information could be supplied the cultivators of the district as to the best method of cultivating and manuring their crops to obtain the optimum yields. A manurial recipe that suits one district will probably not suit another if the soil and climatic conditions of the two differ, neither will the cultural operations adopted in one district be of any use in the other. The work will doubtless entail great expenditure, and will probably take a few years before any tangible results are obtained, but it is essential, if any good is to come out of manurial trials, and if anything like an intensive system of crop husbandry is to be established here. Ceylon yields for various crops are, generally speaking, poor in comparison with those of other countries, and unless greater attention is paid to correct manuring—only arrived at by experimental trial—and correct agricultural methods, the poor yields now obtained will be still considerably lessened. The more urgency therefore for a Soil Survey in Ceylon. Unfortunately Ceylon soils as a whole are of a poor character, its geological nature being chiefly "lateritic." Laterite, as is well known, is formed as the result of a peculiar type of weathering of rocks rich in aluminium and iron, under special climatic conditions such as we find in the tropics—strongly contrasted wet and dry seasons being essential. Others again think that laterite formation is a bacterial process. In any case there is a loss of free silica, lime and magnesia due to the weathering, and a consequent increase of iron and aluminia. Hence the reason for the general acidity of Ceylon Soils. Where carbonates do occur they are chiefly of the dolomitic, i.e., magnesium limestone variety, and hence not of great value to plant growth.

Ceylon, being purely an Agricultural Country, should not be backward where Agricultural Development is concerned. A great deal has been done in Ceylon from the standpoint of pests and diseases, but comparatively little on the chemical side. All progressive and advanced agricultural countries have started soil surveys on a large scale, and even such countries like Mesopotamia, which are only just being developed, are making extensive Soil Surveys, and thus utilising the valuable information and knowledge acquired by scientific research to the benefit of the village cultivator. Work on lines similar to those dealt with should be started in Ceylon, and it will not be long before its benefits will be experienced both by the rich proprietary planters and agencies in Ceylon, and the poor peasant cultivators who form so large a percentage of the agricultural community in Ceylon.

THE PART PLAYED BY BACTERIA IN THE SOIL.

The good old word "tilth" as applied to soil needs to come back into general use. It serves to denote a condition of the land and to set forth an ideal of management covered by no other term.

Keeping it in fettle is something more than the mere mechanical task of tillage. In fact, the German word for tilth, "gare" is frequently interpreted as meaning fermentation. It is an interpretation which fits well, for we know that a good soil is seething with life, pouring forth invisible gases that leaven it and fine its texture, and leaving behind by-products ideal for plant food. And ranked as a chemical laboratory, no learned doctor with his retorts and bottler-arrayed walls can duplicate or even approximate the re-action that Nature working through this life-filled upper eight inches of a ploughed field carried on night and day uninterruptedly year after year.

These midget chemists of the land, the bacteria, play the major role in promoting tilth. In teeming hordes they are present. They often number more than three billion to the ounce of soil, and under many conditions algae, moulds and protozoa are equally abundant. The total microscopic life in an acre of land has been calculated as weighing from 500 to 700 lb., or approximately the equivalent of livestock that a good pasture acre will carry. And while the role that this soil life plays is so complex that it will probably take more generations of close study before the full activities going on under the surface of the land are clearly understood, a few broadly fundamental facts have already been brought to light.

In the first place, it is clear that soil life is necessary for true fertility—that is, for power of the land to produce crops. Not only must this germ life be abundant, but it must be in a healthy well-nourished state and actively multiplying, in order that the land may have that loose, crumbly texture taken as a good omen by the eye of every experienced farmer.

TIRELESS NITROGEN GATHERERS.

Bacteria, for the most part, subsist on organic matter or vegetable matter in the land. Not only does this teeming soil life break down added vegetable matter, producing, or setting free, mineral salts upon which crops directly feed, but one large group of soil bacteria functions in the nitrogen-gathering role probably with as great benefit to soil fertility and tilth as the better-known nitrogen-fixing germs which grow on the roots of leguminous plants. A legume crop will contain from 100 to 200 lb. of nitrogen. Probably half of this comes from nitrogen compounds already in the land, and the remainder is gathered in from the air by the aid of nitrogen-fixing germs with which the roots of the legume are inoculated. We hear much of the importance of having a legume crop in the rotation. We hear, however, but little of the other and greater source of nitrogen supply in our soils. This other great source is through the action of bacteria feeding on the dead vegetable matter.

One leading American bacteriologist recently stated that the quantity of nitrogen fixed in soils by these independent organisms varies from 10 to 40 lb. a year an acre. The larger quantity is often to be found when a plentiful food supply in the form of organic matter is made available for

them to feed upon. These germs, while fixing annually a smaller quantity of nitrogen than is gathered in by a legume crop, more than overcome this handicap through working all the time, and in all soils, while the legume rarely ever occupies the land as much as the half time, and usually only one year in the four-year rotation.

It has been the experience of mankind for ages back that vegetable matter turned into the land made it more productive. Since the establishment of experimental institutions in America an abundance of data has been accumulated, all showing that organic matter in the land takes the leading upbuilding part. But now we know that this organic matter is not used directly by crops; that it must first be broken down by soil life. With the exception of nitrate, acid, phosphate and the various potash salts, plants take no fertilisers in the form we put into the soil. Not only are bacteria necessary in preparing the raw food we supply in form for plants to consume, which is a mineral form, but the bacteria themselves thus fed, gather vast quantities of nitrogen, the most expensive of all plant foods. The quantity they gather seems to bear a close relation to the provisions we make for their food supply. And this conclusion puts the problem of the tilth of the land in a new light.

Soil life also shows considerable preference in its diet. It has long been observed that stable manure in many cases exerts an effect on crop growth out of all proportion to the plant food it contains as shown by analysis, and that the same is true of green matter turned into the land in the early spring. Studies during the recent years have shown that both these substances make wonderful feeding for the bacterial flora of the soil, causing a sharp upward spurt in soil life activity. In pot experiments, a small quantity of green matter chopped into one soil pot almost always caused a sharp leaping ahead of the plant it grew as compared with another plant in a similar pot where the soil was not so treated. It seems there is considerable evidence to justify us in planning cropping systems in so far as soil maintenance goes, with a view to feeding of plenty of vegetable matter to the soil bacteria, and if a goodly quantity of this bacteria food we offer is in a succulent green state, there is plenty of evidence that it will be all the more relished.

We passed through a state of mind not so long back when common observation of farmers, out of line with some half-understood but supposedly wholly elucidated theory, was ranged as mere superstition or old women's tales. Science is to-day more tolerant and less cocksure than it used to be. In fact, some of the hypotheses on which learned men are now working seem more strange and weird than what were ranked as superstitions of bygone times. Our thought with reference to soil problems seems itself to be in a healthy state of ferment.

One bacteriologist, in discussing the role of this microscopic life in promoting tilth in soils, called what we know as poor land "raw" and likened it unto a green cheese, both of which he said were prepared for real food, one for humans by the ripening action of enzymes in the milk, and the other for plants by the ripening action of bacterial activities.

NEW LIGHT ON ROTATIONS.

Take the case of the explanation of why rotation of crops is beneficial. The farmer has long known that by rotation he could keep the land in better tilth, and that he could keep both himself

and the land more regularly employed. Not long ago rotations were claimed by scientists to keep up yields better than single cropping through the fact that different kinds of plants remove plant food elements from the soil in different proportions, and that by changing from one crop to another, the soil supply of plant food was kept more evenly balanced. This point of view has long since been pretty well abandoned. Then for a long while we looked upon rotations as being a means of keeping up fertility through growing periodically a sod or legume crop to boost the vegetable matter and nitrogen supply, and beyond this, shifting crops is a means of keeping both land and labour the more continuously employed.

Now we are finding that different crops act on the soil bacteria in different ways. Legumes, apart from being host plants to what we term symbiotic bacteria growing on their roots, the bacteria being fed carbo-hydrates by the plants and in turn feeding the plants with nitrogenous material apart from the well-known fact, it has been proved is that legume crops specially favour the development of bacteria in general in the soil. Fortunately, most of our cultivated crops seem friendly toward soil bacteria. Some few, notably mustard, are said to be detrimental to the nitrifying and other desirable soil bacteria.

Wheat does not seem to leave the bacterial flora of the soil in as good condition as maize or potatos. European agriculture has pretty well settled down on a system which does not include the growing of wheat oftener than once in two years. The excellent results generally secured from growing mixed crops seem to tie on closely with the observation that the bacterial life of the soil is always found in a more healthy state when several plant varieties are grown together than where one crop occupies the land. And every observing farmer knows that mixed grass pastures and meadows, and of small grains grown for feed, make a bigger yield than when a single variety occupies the land.

While soil bacteria in the main feed upon vegetable matter and the only way to keep the land in a high state of fermentation and tilth is to supply this favourite bacterial food, mineral fertilisers enter into the problem to a more or less important degree. The nitrifying group of germs of the so-called azotobacter group is considered now to be the real backbone of our farming. But for these little busybodies working night and day, our nitrogen balance would be struck so far in the wrong direction that farming would be a more or less hopeless task. This group of bacteria shows a strong liking for phosphatic fertilisers, growing and multiplying at a rapidly increased rate when this element is fully supplied. Possibly this fact explains, fully as much as does the direct plant food theory, good retunrs from far and wide through using phosphate fertilisers.

The bacterial reaction to potash is noticeable, but not so striking. Mineral nitrogen fertilisers show a pronounced effect in this wise: Application of nitrate of soda tends to make the soil reaction alkaline, while the action of ammonium sulphate is to make the soil acid. Bacteria thrive best in an alkaline soil. Alkalinity, however, can be carried too far, causing too great activity of bacteria too rapid breaking down of the soil vegetable

matter and a waste of plant food, as well as destruction of bacterial food, and a consequent period of famine, unless heroic measures are taken to keep up the vegetable matter supply.

There is something in the old saying about lime enriching the father but impoverishing the son. Farmers who use lime liberally should make equally liberal provisions for keeping the soil provided with vegetable matter. Excess lime builds up a terrific bacterial appetite which makes sometimes for a wasteful burning out of vegetable matter that must be replaced or else soil tilth will suffer.

Plants do not take up carbo-hydrates from the soil relying on their own leaf laboratories for the production of these substances. Yet it is a fairly well-known fact that molasses or sugar often shows a great stimulating effect on plant growth. A week ago the writer sprinkled a few spoonfuls of sugar over a fern pot here by my writing table. It had already been liberally supplied with dumpings from my pipe. A new burst of growth and a deepening in colour is now noticeable. The explanation lies in the fact that sugar is ideal food for bacteria, greatly stimulating growth and activity. This more active germ life has broken down the tobacco and other vegetable matter in the pot, and has probably fixed a considerable quantity of nitrogen from the air, making available a bountiful food supply for the fern. Of course sugar is too expensive a product to be used in field application under any circumstances, and I merely cite the case to show how crops are fed by this indirect method of feeding soil bacteria.

We are doing pretty much the same thing when we plant a rotation so as to yield a bountiful crop residue, or to have catch crops or winter cover crops fitted in along with or between the major plantings. We are merely feeding the soil bacteria. And in no inconsiderable degree this is what we do when we apply lime or phosphate fertilisers to the land. Starve the soil bacteria and the land loses tilth. Feed this germ life in the land and the soil mellows and yields its fruit in season.—SOUTH AFRICAN SUGAR JOURNAL. Vol. 7. No. 11.

SUNN HEMP TRIALS IN MATALE DISTRICT.

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Divisional Agricultural Officer, Central,

and M. B. BOANGE,

Agricultural Instructor.

Sunn Hemp (*Crotolaria Juncea*) is grown to a fairly large extent in the northern and north-western parts of Ceylon, where it serves the double purpose of supplying green manure for the paddy fields and providing bark-fibre for the manufacture of twine.

In the drier parts of Matale North, and in many other parts of the Central Division, it is possible to cultivate but one crop of paddy in the year. Usually the crop is grown during the Maha (November to April) season, and the field is unused during the Yala (May to October). In cases where green-manure is applied, it is collected from neighbouring waste lands and

transported to the paddy field, and the experience of the Department of Agriculture has shewn that the cost of collecting, transporting and burying 1000 pounds of green manure varies from *Rs. 5/- to Rs. 15/-* per acre of paddy treated.

It is clear that a leguminous crop might with advantage be grown on the paddy-field during the Yala season and turned under just before field-operations for the Maha season, a method which is used in parts of the northern and north-western districts. Not only might the total weight of green-manure be far greater per acre, but the cost would probably be less, and in addition the land would be utilized and benefited instead of being allowed to lie waste.

In May 1923 a trial was carried out with Sunn Hemp on the standard paddy-plots at Nalanda Experiment Station in Matale North. After the previous paddy crop had been reaped, the fields were dug over and Sunn Hemp was sown. In all, twenty-one plots each of 1000 square feet (50 ft. × 20 ft.) were sown in May and the crop of Sunn Hemp was reaped after it had flowered in September to October. The resultant weights of green-manure were as follows :—

Pounds green manure reaped and weighed

Plot No.	*Per plot*	*Per acre*
A7	564	24568
A1	532	23174
B12	415	18077
C13	376	16378
C3	368	16030
B6	356	15507
C41	337	14680
B14	307	13373
C4	298	12981
C1	267	12630
C7	209	9104
C12	209	9104
C5	206	8973
B13	202	8799
C6	182	7928
C10	159	6926
C2	150	6534
C11	141	6142
C8	132	5750
C15	114	4965
C9	94	4095
	Total 5618	Average 11653

EFFECT OF SUNNHEMP ON PADDY

Note the difference in growth where the Sunnhemp was buried.

The variations in yield are considerable, ranging from 4095 pounds (1¾ tons) to 24568 pounds (11 tons) per acre, with an average of 11653 pounds (or 5 tons), these variations indicating the irregularities occurring in a newly levelled field.

The plots on which these trials were made are small, being each about 1/40th of an acre in area, but the total area planted amounted to about half an acre. The figures obtained for total yield are therefore from a large enough area to be accepted as representative of ordinary field conditions. The land, which had been levelled for only one year, was still raw and probably below the standard of quality of older fields in the neighbourhood. The figures can probably therefore be accepted as representing yields from bad, medium and fairly good soils of the area. Even the lowest yield recorded is from 3 to 4 times the magnitude of an average dressing of green-manure applied to paddy-fields by the villager and the cost of collecting and transport is saved.

From observations made elsewhere, it is practically certain that Sunn Hemp will not thrive on muddy, undrained soils. Where the paddy field can be kept dry during 4 or 5 months in the year, or on hillside soils, the success of the plant seems certain. In the case of the trials under consideration, the fields were moistened with irrigation-water during the earlier stages of growth of the young sunn hemp seedlings, but thereafter no irrigation was necessary. The rainfall for the period was as follows :—

May ...	... ·90
June ...	... 4·10
July ...	... 2·01
August ...	... 3·16
September ...	... 1·95
	Total 12·12 inches

It seems fairly certain that the cultivation of sunn hemp on paddy-fields in Matale North is a profitable undertaking ; and the system might be tried in other parts of the Central Division.

WOOD ASH AS A FERTILISER FOR FRUIT TREES.

A. A. RAMSAY, *Chemist.*

Although wood ash is a useful commodity on account of its potash content, its use in manuring orchards is not to be recommended as a general practice. If applied to heavy soils, injury to their physical condition will probably result, though on light sandy soils little harm may be done. The amount of potash in wood ash varies considerably, but it may safely be assumed that fourteen parts of ash will contain the same amount of potash as one part sulphate of potash. The best means of utilising wood ash is in the form of compost, or mixed with bonedust or superphosphate.—AGRIC. GAZ., N.S.W., Vol., XXXIV, Pt. 9.

PESTS AND DISEASES.

TOMATO CATERPILLAR OR "WORM."

(CHLORIDEA OBSOLETA, SAY.—NOCTUIDÆ)

HENRY TRYONS,

Government Entomologist and Vegetable Pathologist.

INTRODUCTORY.

Moth caterpillars of one kind or another have been unusually prevalent since the winter months in Southern Queensland, with corresponding injury to plant life. In some instances the moths, their progenitors, have occurred in swarms, extending over large areas.

Amongst the cultivated plants that have suffered is the tomato, ordinarily one of the most profitable ones that are being grown; and the depredator in its case that has committed (and is inflicting still) the most serious injury is the so-called Tomato Fruit Worm—the caterpillar of a noctuid moth—named *Chloridea obsoleta*, that in some instances has rendered useless the entire yield. This insect is of no new occurrence here, being described as a pest insect by the present writer in 1889, when already it was well known. Nor is it exclusively an Australian denizen, for it occurs apparently nearly all the world over, including many of the oceanic islands throughout both the temperate and tropical zones. Moreover, its injurious relations are manifested by a very large number of food-plants, including staple crops, such as maize, cotton and tobacco. Its dietary here is, too, as general as it is elsewhere. This and its mode of living constitute it an injurious insect of special prime importance, and volumes of literature have been produced relating to it and its control, although notwithstanding—after years of research—the methods devised fall short of meeting the requirements of the situation. One of the most recent compilations was "Injurious Insects of Cotton—The Cotton Worm," issued in February, 1923, by this Office. This very general dietary amongst plants, its very rapid increase, and its habits, especially with regard to feeding, render its subjugation or control exceedingly difficult.

THE INSECT AND ITS HABITS.

Without repeating what is set forth in the pamphlet mentioned, it may be stated that the parent of the caterpillar is a stout-bodied moth measuring about ⅔ inch in length, with a wing-spread of about 1½ inches. When settled, the front wings—usually drab coloured with indistinct brown markings—almost conceal the hind ones, that are whitish with broadly black tips; the former making rather a wide angle with the body and sloping away on each side. These moths are nocturnal in their habits, generally speaking, and occur concealed settled in herbage, or under earth clods during the day, but moving off with dart-like rapidity when disturbed.

The moth feeds on the nectar or honey of different flowers, usually after sundown, but occasionally during daylight, when it may be seen with quivering wings on the blossom it affects.

Each female moth, according to estimates made, may lay from 400 to 3,000 eggs, the average being about 1,000. Moreover, it may commence laying—having meanwhile mated—on the second day of its emergence from the chrysalis, and continue laying for ten or twelve days after this. These eggs are at first whitish in colour and measure about one-fiftieth of an inch across (about half the size of the head of a small pin) and are low dome-shaped, almost spherical, with a series of fine ribs radiating downwards from their tops. They darken as they mature or when parasitised. In the case of the tomato, they are usually placed (always singly) on the green calyx-segments of the flower bud or flower or on the tender tomato growth; but when the insect is numerous, elsewhere.

Our assistants, T. H. SIMMONDS B. Sc., and J. WEDDELL, referring to a marked incident of this nature, recently informed us as follows :—

"Eggs were found on stems, foliage, calyx, petals, stamens. In one case, five eggs were seen clustered on the petals of one flower. The following counts of eggs from one branch, consisting of about six leaves and two flower sprays, were made :—Leaf, 5 eggs on under surface, 6 eggs on upper; flower, 10 eggs on petals and 3 eggs on calyx." Sometimes all the eggs laid will give rise to caterpillars, but as A. A. GIRAULT, Assistant Entomologist, discovered in the course of investigations in the United States in 1905, commonly many do not do so.

The eggs, when deposited, are capable of hatching in as short a period as three days, but usually rather more than four elapse before the tiny pale dark-headed caterpillars emerge. These caterpillars may exceptionally come to maturity amidst the foliage of the tomato plant, but usually speedily repair to the green fruit, tunnelling their way into it near the calyx end, even when this is partly grown. More frequently, however, as the outcome of the situation in which they are deposited, the minute ovary as it is formed receives their earliest attention. On this subject MESSRS. SIMMONDS and WEDDELL again have observed as follows :—

"In several cases the petals had been eaten and young fruit beneath just commencing to 'set' also eaten. Once, on removing the petals and stamens, a very young larva was found inside on the developing fruit."

From the first scene of the insect's depredations, especially in cases such as these, the growing caterpillar passes from one fruit to another, injuring all in turn. Thus a single caterpillar may do considerable damage, since every fruit entered is "done for" so to speak.

The caterpillars each have a larval period of about two weeks on an average, but this may be extended to three. During this time they vary greatly in appearance with each of the six changes of their skins, being unstriped during the first two instars. (Further description is unnecessary in writing for tomato growers.) When full grown it is about $1\frac{4}{5}$ inch long.

When this happens, the caterpillar drops to the ground and digs its way into it, after moving off, if at all, usually but a few inches only. Thus it enters to a depth in it of from $3\frac{1}{2}$ inches to 6 or 7 inches—usually, say, 4 inches. In this position—after first making a special exit tube that nearly reaches the surface again—it forms a little oval cell in which it transforms

to a smooth, glossy-brown chrysalis having two straight thorn-like bodies at the tail end. (*Note.*—Should the soil be covered with rubbish, the chrysalis chamber may be nearer the surface.)

This chrysalis or pupal condition varies in duration according to the temperature to which, when in the soil, it is subject. It may be short as ten and a-half days, but be many days longer if cold be experienced. In a temperate climate where frosts constantly occur during the winter, the insects may live in this condition for eight to nine months. When, however, the full period has been reached, the insect comes forth from its chrysalis.

NATURAL INCREASE AND CONTROL.

The foregoing remarks will suggest that between one egg-laying and another, on the part of the succeeding moth generations, from twenty-eight to thirty-two days may elapse only, and with a congenial climate like that of Southern Queensland it may be readily understood that there may be many generations of moths, and so many distinct broods of caterpillars during such a long season as is devoted to tomato-growing in the latitude of Brisbane. These broods, however, are not distinctly defined, as all the moths of one age do not emerge on a single day and oviposition in the case of any one individual extends also over several.

The theoretical potential increase, however, is perhaps never realised, as natural conditions supervene to obviate this. These are weather conditions, food conditions, and natural enemies—birds, insects and diseases. On the other hand, as has recently happened, these natural agencies for controlling numerical development and crop injury have evidently been restrained in their activity and hence the loss of crop.

There is, however, in the presence of parasites of the Tomato Caterpillar that have come upon the scene, some prospect of natural enemies operating to restore normal conditions, notwithstanding the immense toll on insectivorous bird life arising from extensive bush fires operating during the breeding seasons, when all birds are animal (insect) feeders—fires often wantonly started. These parasites that have been observed by the staff are a minute egg-parasite (Trichogramma), a caterpillar fly parasite (Tachinus), and an Ichneumon parasite ; but as yet the extent to which they are operative has not been ascertained. Again, disease that is present with the occurrence of wet weather might prove especially virulent towards the insect.

MEASURES OF CONTROL.

Field Practice.—Avoid growing in the vicinity of crops of tomatos plants that in common with it afford sustenance for the insect, unless they, too, receive continuous attention directed towards its repression. This especially applies to maize, cotton, cape gooseberry (*Physalis*), rossella, and tobacco, but also to plants that receive less attention by the Chloridea than they; thus peas must not be ovorlooked, and so also certain ornamental plants such as snapdragon or Antirrhinum.

Wormy tomatos (being already rendered useless) should be gathered and destroyed; burying to a depth of 1 foot will in most cases meet the latter requirement. This will prevent sound fruit being visited by caterpillars from injured fruit; but it will also destroy those "worms" that otherwise would leave it, to enter the soil to give rise in a few days to moths whose

progeny would intensify the trouble. Tomato plants when eradicated shoud also be burnt, as soon as practicable, rather than left in heaps on the headlands.

Prior to planting, and especially when contrary to what is above suggested, devoting the same area to immediate successive tomato growth and in which case as long an interval as may be found convenient should be observed, the soil should be well cultivated and turned over more than once. Thus will be exposed to the fatal action of birds and the weather those insects dwelling in it, either as chrysalises or caterpillars about to change within their earthen cells. So also when the tomatos are being grown the soil should be cultivated wherever it is admissible to do so. Should again a "green crop" such as cowpea or Mauritius bean, that may harbour also the insect be ploughed under prior to planting, this should be well covered under and pressed down by rolling, so that any caterpillars present be destroyed.

As far as economic considerations will admit of it, crops that are not attacked by this insect should be grown in alternation with those that are—*e.g.*, cucumbers or rock melons as a substitute for tomatos.

Trap Crops.—Observation indicates that although the insect reared as a moth from one kind of plant has often acquired a liking for it again, generally speaking, there are those that it especially favours. This especially applies to maize as compared with tomato, particularly to the cooking variety known as sweet corn. Maize is therefore commonly grown in other countries as a trap crop in protecting cotton from its injurious presence. It is especially serviceable in dealing with the first brood of insects. Its value as a trap entirely depends, however, on its being taken out and used as or converted into fodder, as soon as or shortly after the silking stage has been reached. Otherwise it will serve whilst attracting the moths from all round it, to furnish in due course others to attack the plant it is intended to protect. Obviously it is not implied that maize can be grown as a substitute for the tomato as a crop of equal monetary value, but when no yield of tomatos is promised owing to caterpillar attack its growth may be profitable. Under special circumstances the use of a special "green manure" plant, *Canavallia striata*, whose pods are favoured by Chloridea, has been adopted with some success as a trap crop.

Trapping and Repellants.—With regard to methods of destruction directed against the moth itself, the very extended experience of entomologists in other countries, as well as in Australia, does not afford much promise of success. It is not at all or very seldom attracted by light, and therefore special trap lamps, torches, or fires are not available for its capture and destruction. Again, the same remark applies to baits, with or without poison incorporated in them, so useful in coping with the final forms (moths) of other destructive caterpillars. Nor do we know of any substance that will with certainty repel attack on plants threatened. Our Queensland experiences suggest that Bordeaux mixture, when well applied, has some efficacy as a deterrent, but the caterpillar being an internal feeder, except when in the earliest stages of its life, any deterrent has only a transient use.

Contact Insecticides.—This also applies to the use of contact insecticides, on whose efficacy success in coping with other plant injurious insects is so noteworthy. Here, however, we are further confronted with a plant very liable to injury by these potent applications with too abundant foliage to be affected by them. Our assistants, MESSRS. J. H. SIMMONDS, B,Sc., and

J. WEDDELL, have, however, pointed out that the "worm" is often partly exposed when tunnelling in the fruit and thus not only so when recently emerged from the egg, and so then may also be reached by a direct application, and the writer proposes to test the action of DERRINE (that is not plant injurious) under these circumstances.

Food Insecticides.—The use of arsenic-containing insecticides, and the same applies to those containing antimony or cardmium, is not always attended with profitable results. In fact, under field experimental conditions elsewhere, more wormy fruit has been noticed on tomatos after the application of arsenate of lead (or Paris Green) than on control plants that have not received any. The better results from the use of these bodies will, however, be reached by closely noticing when the prevalence on the plants of the moth's eggs occur, and then spraying about a week subsequent to this event, a small hand magnifier being useful for the perliminary observation. The application of these insecticides in the form of powder diluted with corn meal, ground sulphur, lime, ashes, etc., is favoured elsewhere, but success in this case is conditioned largely by the state of the atmosphere, since when the air is dry the insecticidal powder is liable to be soon blown away. For the same reason it must be applied very early in the day when dew is still upon the plants or when light rain is being experienced.

Insecticide and Fungicide.—As a routine treatment of tomato, as well as of potato plants, this Office has persistently advised the application of Bordeaux mixture, of 4-40-4 strength (freshly slaked lime 4 lb., bluestone 4 lb., water 40 gallons) made quite neutral, and which is especially adherent if a little soap solution, or perferably molasses, be incorporated with it. This treatment is recommended as a preventive of blight and of less harmful leaf disease, the former of which at times is quite fatal to the tomato. Arsenate of lead may be combined with this fungicide, and 1 lb. to 24 gallons (six kerosene tinfuls) is the amount of it that should be added. As, however, with its use as a fungicide only several applications are necessary. This, however, should have some reference to the general hatching of the eggs of each moth brood, rather than to the lapse of so many days. Spraying also should be commenced very early so as to catch the first brood, as it is very necessary to concentrate on this. In Sumatra the same insect is very harmful to the tobacco, and there the plants are sprayed whilst still in the seed bed.

The Bordeaux mixture slightly reduces the potency of the poison, but then it promotes its adhesiveness to the plant as well as exerts some deterrent action in warding off attack.

NATURAL ENEMIES.

Sedulously preserve native insectivorous birds. Even many of those proclaimed "pests," if permitted to operate over the soil of a tomato field undergoing cultivation would rid it of the insects then occurring thereon.

A study of the parasites of *Chloridea obsoleta*, as recorded in the world's entomological literature, does not leave much hope of any efficacious work in reducing the insect, through the introductions of ones not already occurring here. Borneo is the only country apparently in which this method has been essayed, and its effort has been concerned with an egg-parasite that, as it seems, already occurs here.

The very slight extent, if at all, to which *Chloridea obsoleta* occurs to an injurious extent in Egypt in relation to the different plants it is associated with there seems to receive its explanation not in the work of parasites but in the cultural treatment that the soil there persistently receives. So also to a less degree with respect to British India.—QUEENSLAND AGRIC. JOURN., Vol. XX, Pt. 5.

AGRICULTURAL EDUCATION.

THE TEACHING OF AGRICULTURE.*

SIR A. DANIEL HALL, K.C.B., L.L.D., F.R.S.,

Chief Scientific Adviser and Director-General of the Intelligence Department of the Ministry of Agriculture.

I cannot help feeling that the object of my remarks is still somewhat in a tentative condition, and it may be better if I reserve a formal exposition of the subject so that all I have to say may be regarded by way of stimulus and suggestion rather than a direction to a particular action that I should like to see taken. This mnst be the case with all good teaching. The teacher has to work out a method, that method may not be a good one for universal adoption, but if a man has worked it out for himself and is keen, the very fact of his keenness may make that method an extremely profitable one.

Closer Consideration of the Method of Teaching.—What I have to bring before you is this, put broadly, that the actual method of our teaching, whether we teach inside the college or the farm institute or whether we teach in the country, requires more consideration than it ordinarily gets. We all of us in this country begin teaching agriculture in a thoroughly haphazard amateurish fashion. We go to college and later on when we leave, we find ourselves put in front of a class and required to teach on our own account. I think most people's experience would be similar to mine; no one gave me a hint or suggestion of what methods to follow—I floundered about and tried one method after another.

Many scientific and technical men have a certain scorn for what generally may be called the art of exposition, whether in speech or writing. In writing I have often occasion to deplore the style and quality of the written matter that is put out. In teaching I have from time to time listened to lectures and classroom instruction, and I do not think the teaching might be enormously improved if the men thought a little more about this matter of teaching as an art in itself, independent of the material that is to be set forth, an art which has a code of rules and laws of its own. I do not want to lay down methods at this moment. Every man will think out his own method, but I do want to plead for a consideration of the method itself as something worth thinking about, something by which the work—whether it is in classroom or lecture room—can be made more effective. I want you to take it that teaching is not a process into which you drop quite naturally, that it only involves the doling out of so much information to be got up by the class, whereby all the teacher can be expected to do will have been accomplished. If that were the case, if there were nothing in the functions of the teacher but to hand out a certain amount of knowledge, why have

* The substance of an address given by SIR DANIEL HALL to the Agricultural Education Association at Aberystwyth on 10th July, 1923.

any oral teaching at all ? Why not content oneself with books, or with some kind of organisation like the correspondence college ? The organisation of a correspondence college for example can show the student exactly what he ought to read, it can set him papers, mark and comment on them. The way these colleges flourish proves that they can be effective in promoting the acquisition of knowledge for examination purposes. In fact one must take that the very existence of these correspondence colleges on a large scale points out that there is a defect in the ordinary teaching given in the country. If the oral teaching were of the right kind the correspondence college, which gets its results and could not live if it did not get its results, would go out of existence.

To give an illustration of what I mean ; you are all familiar with one of the very commonest forms of classroom teaching in University or University College—the lecturer who practically dictates to his students a certain text which he has prepared. The lecturer prepares very carefully his lecture as a résumé of a particular section of the subject and delivers this from the platform so that every student may take it down verbatim and get it accurately transcribed into a note-book. That form of instruction is very popular, especially amongst students. It supplies them with a short-cut to knowledge; it absolves them from the necessity of reading anything other than their notes. They need not buy text-books ; still less need they compare the different views of other people on the subject, and they regard this as a very profitable form of instruction. If they get up the notes which the professor has given them they expect to be able to pass the required examination. One knows the type of lecture note-book which is produced in that way, and I believe in some of the Universities it has considerable financial value. That always reminds me of a story of a Cambridge undergraduate in the time of a very famous coach known as Big Smith. The undergraduate had just come into residence and was taking counsel with some senior friends as to what course to pursue, should he read for Honours or a Pass. He asked what was the difference between a Tripos and a Poll degree. The old hand replied "if you go for the Tripos go to Brown, of Trinity, and he tells you what he thinks about it ; then you go to Jones, of Jesus, and he tells you what he thinks about it ; then you go to Tomkinson, of Caius, and he tells you what some other Johnny thinks. If you take a Poll you go to Big Smith and he tells you what it *is*." That is the attitude of the typical undergraduate ; he wants positive knowledge delivered to him in neat little packets ready to be handed over the examination counter. I submit, however, that the teaching of that kind will eventually be replaced by the gramophone. It would be cheaper to the University to replace such professors by gramophones.

Of course there is the converse of the process, where the lecturer refuses to allow his students to take a note at all. That was my own practice in the later days of my actual teaching career. I was asking my students for their attention ; I did not want them to divert their attention by taking notes. The object of my lecture was to impart a point of view and to get my students to apprehend the principles of the subject. So far as notes went it was my practice to issue a typescript at the end of the lecture, which contained subject headings, tables and diagrams, and

references to the text-books indicating where details of the matters dealt with could be found. I do not say mine was the right way but it was an attempt to teach, whereas the other way is only an attempt to supply information. I throw out that as an illustration ; the point I want to make is that the mere process of teaching does require thinking about.

On the other side let us take the outside lecture, the lecture that every college or institute teacher is required to give from time to time to audiences in villages and country centres. As a rule the preliminaries are organised for him ; he walks into the place and is rather apt to suppose that if he delivers the lecture and the people do not leave the room in too large quantities during the process, that his method is good. If the audience falls off during the lecture course, he blames the organisation.

But we have to ask ourselves whether the lecture method is suited to the village audiences at all, whether the type of teaching we have to do in the counties has not to start from an entirely different point of view. I want to suggest that the prime effort of the extramural teacher must be in some way to drag the members of the audience into the fray themselves. They must be led to become active participators in the process of education. You have not much time in dealing with an audience of that description ; you are running over the whole of agriculture, perhaps in six lectures and you only have time for stimulus. The technique of the process by which you can get your pupils to read and work for themselves does require a good deal of consideration. Put yourself the question, "How am I to get my audience to help themselves ? I, in charge, can only help people, I cannot teach them : I can only point out the lines upon which they can teach themselves."

How we can Improve our Methods of Teaching.—I take these as illustrations of the kind of subject I should like to see discussed, the methods of teaching inside and outside the college, how, by thinking for ourselves, we can improve our own methods. I want specifically to suggest the question of how the subject of agriculture itself ought to be treated in our Colleges and Farm Institutes, etc., because there I can see perhaps the greatest opening for better technique and indeed for some considerable reconstruction of our aims in teaching agriculture.

I think we are inheritors in this country of rather a mistaken tradition. I know quite well 30 years ago when colleges began to start in Great Britain for the teaching of agriculture, the general idea of their founders was that agriculture could be regarded as an assembly of applied sciences. There was chemistry, botany, zoology, geology and so forth, all sciences throwing light upon the growing of crops and the feeding of animals. If we first taught these sciences to agricultural students and then the application of those sciences to agriculture, we were teaching agriculture. You may remember that the first Cambridge diploma did not proceed further than that. It was content with an examination in applied sciences and treated agriculture itself as one of those rather mechanical extras which are pursued in practical life but which should hardly concern the university. So I think we were given a set towards the treatment of agriculture as just an assembly of applied sciences, and it was conceived that we could bring out a farmer by grounding the youth thoroughly in chemistry, botany, zoology and so forth.

Now agriculture is a subject *sui generis*, something, quite distinct from an applied science; it has its own technique and methods and its own fundamental science, which is neither chemistry, botany nor zoology, nor anything of the kind popularly termed science. It is accountancy which lies at the basis of the teaching of agriculture, and as pure chemistry is the grammar of the agricultural chemist and botany of the agricultural botanist so is accountancy the grammar fundamental in the instruction of the farmer.

The Object of our Teaching.—If we start off with that somewhat one-sided statement we shall get a little nearer to what is the right form of teaching. Let us begin by asking ourselves what we are after when we are dealing with the young men in an agricultural college. What is our object: what are we going to try and turn out? I think it is agreed that we are not thinking of turning out teachers, officials or that kind of man; we are thinking really of turning out a thoroughly equipped farmer and we want to ask ourselves what we mean by that—a thoroughly equipped farmer under modern conditions, and how we can help to ensure that type of man by education. We know well the old farmer who has no education behind him; he tells the teacher that no-one can learn farming in a class-room and that he has no opinion whatever of book farmers. The answer is not easy, but I think we can remove that kind of reproach if we take our teaching of agriculture from a somewhat different angle. What he means is that success in farming depends upon a number of qualities which are personal and many of which are only obtained by experience. If a man has no will or determination, if he lacks a certain firmness about making a bargain, of course he cannot become a successful farmer—and none of the efforts of the educator are directed towards giving these qualities.

Still, putting aside these inborn faculties and the essential matter of experience, what does characterise a good farmer as distinct from a bad farmer? We can sum it up in one word—management. The good farmer not only knows what work had to be done, what good work is, the technique of growing his crops and breeding cattle, etc., but he knows how most effectively to dispose of the staff of labour that he has on that particular land, His job as farmer is a manager. The agricultural college is dealing mainly with men who are going to be managers of labour, directors of other people's work. They are not going to do manual work themselves, except perhaps in their younger days, but in the main they are going to be heads and not hands.

Developing the Idea of Management.—When you turn to compare the successful with the unsuccessful farmer you will probably find in a great many cases that the question of financial success depends upon this disposal of labour more than anything else. We may sum up the object of the agricultural college as the training of managers. That being the case what I want to submit to you is that we must direct our teaching to that end.

Suppose we turn to one of the most successful text-books on agriculture that we have in England, the late PROFESSOR FREAM'S—almost the only widely distributed text-book that has been written in English on agriculture—do you find that point of view, management, set out from the beginning of the book to the end? There may be an odd chapter or two about it, but in the main the book is concerned with the description of the

materials of the farmer. You are told how to discriminate between fescues and poas, hop trefoil and yellow clover—just the kind of things that are so much taught and learned by the agricultural student and so heartily despised by the old type of farmer. The old farmer is wrong; you cannot know too much of anything. None of these descriptive points are without their value, only they cannot replace the other things, the vital study of the economics of a farm and its management. That is the point that I want to bring forward in these remarks.

The teaching of agriculture as I have seen it, and I speak from experience, is far too much a mere matter of description. It may not even be descriptive of the kind of farm the teacher knows himself, it may be a discussion on the old systems of farming. It is not unknown that men continue to teach the East of Scotland form of agriculture as described in STEPHENS' "Book of the Farm" as the only method of successful farming. It may have little to do with the farming that was going on round about the college, having been worked out on a different rotation and for a different soil and climate. Let us have done with this purely descriptive teaching of agriculture.

The teaching of agriculture should be to an increasing degree a matter of personal experience, and it should be in every district largely based upon what is going on round about the college. It should begin as a description, so far as it is descriptive, of the farming practice amongst the people the student comes from; that is the first thing; let us localise our teaching. In this way the teacher can introduce the element of personal investigation; he begins by finding out what the people round about are doing, that will lead him to comparisons of their methods with other people's methods. He can fall back on the standard system of his text-book, compare it with the local system and discuss the difference that he finds between the two. The critical faculty is brought into play.

But we must go a step further if we have in view management, so that the student, when he leaves college and begins to work on his own account, shall be in a position to be critical of the work that he gets done, and not merely in the hands of his foreman or bailiff. We must not be content merely with describing. We must ask ourselves about each of the processes, how many men, how many horses, how much time, what will it cost step by step, and criticise these costs in the light of the results. Here the real critical process comes into play. The agricultural teacher dealing with, say, the potato crop, should have acquired for himself, by direct observation, a picture of the practice of a successful potato grower under certain conditions. He has followed the crop through, he has found out the number of men at work and the amount they did, and he is in a position to sum up the costs. That alone is a description which may be of great help to a student later on. But if he can set alongside that a description of the methods of two other equally good farmers and in different districts with the details of the alternative operations, the number of men on the job and the costs, I should think he is entering his students in the art of being managers. That is the first step. It has not got to end there.

After the teacher has been through the raising of crops and the treatment of livestock as individual operations, he has got to get his students into a perception of how a really good farmer schemes out his work from week to week, and how, given a certain staff at his disposal, he uses them to the best advantage. From my own observation of practical farming

there lies the difference between the successful and the bad farmer—the way in which a good farmer has his work planned out and with a given staff always is ready to throw in his strength at the right moment. Of course you cannot fetch that, but you can awaken the student very much to the necessity of thinking it out for himself.

It is in that connection the college farm is going to be most useful for the purpose of the teacher. The college farm should be run as a practical business proposition which is illustrating management and which is a text-book of the teacher in the lessons he is giving. Every student should keep an exact diary, week by week of the operations that go on on the college farm, and it should be a diary with full details. It does not record "March 15th, sowing barley on the 10-acre field." No, he says "sowing barley on the 10-acre field; wheat stubble ploughed in November, wanted more frosts, a little stale on top and wet below." Then should follow the operations, the horses and men to each and the time taken. Further, the teacher should be giving the actual cash transactions from week to week. The teacher taking his class on Monday morning will say "our business during this week is so and so, I propose the men shall do so and so," and he shows them how he has schemed out the use of his staff during the week and the alternative in case the weather is unfavourable. It is in this way we can make our agriculture itself scientific, and not merely descriptive of accessory scientific facts which may be of value but which are of secondary importance compared with the question of management.

When we get on to the second and third year of teaching we have to consider broader economic questions; the reason for this or that branch of the business, why we are producing milk, why we are fattening bullocks, etc. We can begin with a consideration of the policy of the college farm, for it is the one which is close at hand, the one about which the teacher has the most details. But neighbouring farmers are generally willing to help the college by disclosing enough of their accounts to give the teacher materials for the discussion of policy. Now this means that agricultural teaching should be founded upon a system of cost accounting. The feature of efficient management depends fundamentally upon a good book-keeping system to begin with, and the constant use of that book-keeping to check operating costs, so I think that the student must be inducted early into the point of view of cost accounting.

We are apt sometimes to assume that we can describe the right method of farming. I do not think there is a right method of farming, there is only a best compromise to adopt under given circumstances as regards soil, climate, markets, etc. The teacher's object should be to get the student into a critical way of examining other people's work so that eventually he will pass on to criticise his own work. The machinery for this is only to be supplied by a sound system of costing. Therefore the teacher of agriculture should investigate costs for himself so as to establish a comparative system of teaching comparing A's methods with B's methods and discussing with his class how relatively they arrive at the same ends though one may cost a little more. He is then in a position to criticise the whole conduct of particular farms, always with the management in view, and the results in cash as the fundamental test of the rightness or otherwise of the operation.

I do not think I need say anything more. I could have elaborated but I rather want to throw out these suggestions for you to turn over for yourselves and see if they will not strike on your box and modify the methods by which you teach. I am convinced that if you think about these points of the technique of teaching, you can make your work more effective.—JOURN. OF MIN. OF AGRIC., VOL. XXX., No. 9.

CEYLON AGRICULTURE.

FOOD PRODUCTION AND AGRICULTURAL COMMITTEES.

ANURADHAPURA.

Minutes of a meeting of the Anuradhapura Food Production and Agricultural Committee held at the Kachcheri on 1st December, 1923.

Present:—Mr. A. W. Seymour, Government Agent, North-Central Province in the Chair), Messrs. H. R. Freeman, B. W. G. Tennekoon, Kachcheri Mudaliyar (Acting Ratemahatmaya, Kalagam Palata), and C. C. Woolley, Office Assistant to the Government Agent, N. C. P. (Secretary).

1. The Minutes of the previous meeting held on the 1st September, 1923, were taken as read and were confirmed.

2. The meeting was informed that 8,000 jak seeds for Rs. 20/- and 4,000 jak seeds for Rs. 10/- were purchased and distributed among the villages and the school gardens respectively and that the Manager, Seed Store, Peradeniya, states that, if further seeds were required, they would be supplied without further cost. It was resolved to apply for a further similar quantity.

3. The correspondence with the Divisional Agricultural Officer, Northern Division, regarding the supply of sugar cane cuttings to villagers—vide resolution No. 12 of the 3rd March, 1923—was submitted for the information of the members. The Director of Agriculture had made available supplies of sugar cane cuttings at Rs. 2/- per 100, but so far no villagers had applied for them. Mr. TENNEKOON, Acting Ratemahatmaya, Kalagam Palata, said that he would report on the requirements for Kalagam Palata.

4. The meeting was informed, in reference to the question of the disposal of the unallotted lots in the Ratmale Colony—vide paragraph 16 of the minutes of the last meeting—that the matter was still under consideration of the Hon'ble the Controller of Revenue.

5. The Divisional Irrigation Engineer, Northern Division's letter No. 331 of the 22nd September, 1923, expressing his disagreement with paragraph 18 of the minutes of the last meeting regarding the failure of the Pankuliya Yala crop, was read.

6. Government Agent's letter No. 430 of the 29th September, 1923, to the Hon'ble the Treasurer giving details of expenditure during 1922-23 of Rs. 3,127-54 from 'Profits on Food Control' Fund and asking for re-vote of the balance of Rs. 372·46 and the Treasurer's reply No. 17845 of the 19th November, 1923, authorising payments were read.

7. Petition No. 4729 of 1923 from P. B. WERAGAMA praying for an advance of Rs. 500 for the purchase of buffalos was refused as there were no funds available.

8. It was resolved to advance a sum of Rs. 64/- to a villager of Konwewa to purchase seed paddy—vide resolution No. 10 passed at the last meeting.

9. Petition No. 4917 of 1923 from the villagers of Aliyawetunuwewa in Maminiya Korale praying for assistance to construct a well was considered. It was decided to recommend to the Government Agent that this will be placed on his waiting list.

10. Letter No. 3564 of the 15th November, 1923 from the Secretary, Board of Agriculture, asking to submit the name of a representative for membership of the Board of Agriculture for the next three years was considered. It was resolved to recommend Mr. FREEMAN.

11. Letter No. 2550 of the 1st November, 1923, from the Divisional Agricultural Officer, Northern Division, regarding Shows and Competitions for 1923-24 was considered. It was resolved to continue the system of competitions adopted last year, i.e., to allot Rs. 50/- as prizes for each Division, competition being restricted to paddy cultivation only and the rules being those as approved by resolution No. 5 of the 3rd March, 1923.

12. On Mr. FREEMAN's enquiry, the meeting was informed (i) that all the lots available under Nachchaduwa for lease to the small holders have been allotted ; (ii) that there are still 90 applicants on waiting list; (iii) that there is no objection to immediate occupation of the lots on payment of rent; (iv) that the applicants who have been allotted lots are given time till 1st January, 1924, to inspect the land if they wish; and (v) that the rent will be considered payable as from 1st April, 1924, although occupants may enter the land now.

13. MR. FREEMAN asked (a) if the Government Agent would recommend that the land between the Pawatkulam bund and Pawatkulam old field (about 20 acres in extent) be granted to the Pawatkulam shareholders on food production permit and (b) when the food production permit would be given to the Hidogama people for the 35 or 40 acres adjoining the tisbamba. In reply, he was requested to direct the people to send applications, which will be considered by the Government Agent.

14. On MR. FREEMAN's suggestion, it was decided to recommend to the Government Agent that lot 109 in I. S. P. P. No. 3 (Hidogama) be advertised for sale as early as possible.

15. In reply to MR. FREEMAN's enquiry the CHAIRMAN stated that in the capacity of Government Agent he would cause inspection of a new gangoda site for Hidogama to be made, as the present site was reported to be swampy and unhealthy.

16. MR. FREEMAN submitted an application from the people of Pahaluwewa for 20 acres of land on food production permit. The CHAIRMAN stated that as Government Agent he would arrange for an inspection of the site to be made.

17. On MR. FREEMAN's enquiry, the meeting was informed that it has been decided to sell by public auction the Ceylon Mills Co.'s land under Kalawewa and that the Government Agent would receive applications for the same.

18 On MR. FREEMAN's enquiry, regarding applications for land along the Batticaloa-Trincomalee Light Railway trace, the meeting was informed that one application had been received for 100 acres of land in Tammankaduwa on food production permit.

19. On MR. FREEMAN's enquiry, Divisional Irrigation Engineer, N.D.'s letter No. 420 of 28-11-23 stating that the Kennedy Gauge Outlet to feed Hidogama Tank was placed for experimental purposes and that a sluice of adequate capacity would be provided, was read.

20. On MR. FREEMAN's enquiry regarding the raising of the road through Gonwewa Tank to prevent loss to cultivation, the meeting was

informed that information was being collected to place the matter before the Public Works Department.

21. MR. FREEMAN undertook to submit at the next meeting figures of cost of cultivation of land at Pankuliya in connection with the Yala water supply question.

22. MR. FREEMAN withdrew his question regarding the earth work for Tammannewa bund, as he said that he had received a satisfactory reply from the Government Agent.

23. MR. FREEMAN enquired whether the Government Agent would sanction some gingely chenas for the next Yala season, especially in the Willachchiya and Nuwaragam Korales, the driest part of the Province. The meeting was informed that the Government Agent intended making a circuit in this area and would investigate this matter.

24. MR. FREEMAN was informed that repairs had been effected to the majority of spills and sluices of the list furnished by him in 1922 and that work on some was now in progress.

25. On MR. FREEMAN's enquiry, the meeting was informed that an estimate for Rs. 8000/- to repair Kidawarankulam breaches had been framed and that the estimate was now under consideration by the Irrigation Department.

KANDY.

Minutes of a Meeting of the Kandy Agricultural Committee held at the Kandy Kachcheri on the 8th December, 1923, at 9 a.m.

Present.—The Hon. the Government Agent, Central Province, the Divisional Agricultural Officer, Central Division, Ratemahatmayas of Yatinuwara, Harispattu, Pata Hewaheta and Uda Bulatgama, Chief Interpreter, Kandy Kachcheri, the Plant Pest Inspector and Messrs. D. J. Blyth, W. R. Hancocks, J. P. Blackmore and J. C. Ratwatte Dissawa.

The Divisional Agricultural Officer, Central Division, took the chair till the arrival of the Government Agent.

1. Tabled the replies from the Ratemahatmayas regarding rat and crab pests in paddy fields. The Plant Pest Inspector gave the result of work in India, and asked for copies of reports of Ratemahatmayas and specimens of local rats. MR. J. C. RATWATTE, Dissawa, stated that a paddy field of his at Pallemahiyawa was being damaged by rats and invited the Plant Pest Inspector to visit it.

2. Tabled a leaflet on shows and competitions in Nuwara Eliya district for the information of the members.

3. Read letter No. 3,203 of 22nd October, 1923 from the Divisional Agricultural Officer, Central Division, informing that the following allocations for Grants-in-aid for Agricultural Shows and Competitions had been made to the Central Division :—

		Competitions.	*Shows.*
		Rs.	Rs.
Kandy District	..	300	200
Matale ,,	...	600	200
Cacao Competition (Matale)	...	240	—
Nuwara Eliya District	...	225	100
Kegalle District	...	400	100
		1,765	600

Total Rs. 2,365·00

4. Read letter No. 3,259 of 26th October, 1923 from the Divisional Agricultural Officer giving results obtained from 21 plots of sunnhemp at Nalanda Experiment Station during Yala season 1923. The yield varied from 24,568 lb. to 4,095 lb. per acre—10 tons to 2 tons per acre. Sunnhemp is grown in the Northern and North-Western parts of the Colony. The fibre produced from the bark is a recognised commercial article used for twine-making in Ceylon. At Nalanda it was planted chiefly as a green manure for paddy. In drier parts of the Colony, where the fields are not cultivated for Yala it would be possible to grow sunnhemp and turn the whole into the soil as manure or extract the bark fibre and return leaves and refuse to the soil. The method is worthy of trial by cultivators.

5. Read letter No. 3,335 of 30th October, 1923 from the Divisional Agricultural Officer, Central Division suggesting to hold a tea growing competition amongst owners of small tea holdings in Udunuwera. The Committee approved the suggestion.

6. Read letter No. 922 of 19th November, 1923 from Ratemahatmaya Harispattu informing that the Harispattu Show has been postponed indefinitely. The Ratemahatmaya stated that the idea is not abandoned though postponed indefinitely.

7. Laid letter No. 3,609 of 28th November, 1923 from the Divisional Agricultural Officer suggesting to recall the Rs. 125 allocated for Harispattu Show. Resolved to recall the amount and to expend the money as suggested by the Divisional Agricultural Officer, viz :—

Prizes for Alawatugoda Market Show	...	Rs. 70·00
Prizes for Pupils, Home Gardens	...	Rs. 36·00

cancelled the issue of silver medals.

The balance Rs. 19 to be kept in hand for printing advertisements regarding these competitions.

8. Read letter No. 3,565 of 15th November, 1923 from the Secretary, Board of Agriculture, to nominate a fresh member to serve on the Board of Agriculture. MR. P. B. NUGAWELA, Diyawadene Nilame, was elected a member of the Committee and nominated to serve on the Board of Agriculture.

9. Laid letter No. 3,586 of 27th November, 1923, from the Divisional Agricultural Officer with leaflets on Shows and Competitions for discussion. The printed leaflets were adopted with the exception of Harispattu Show and vegetable garden competition of Harispattu.

10. Read letter No. 683 of 23rd November, 1923 from the Ratemahatmaya Yatinuwera regarding the destruction of jak trees, which produces food and timber. Resolved to suggest to Director of Education to give through schools propaganda insisting on need for replanting when any trees are cut, and also to give prizes of Rs. 15 and Rs. 10 for the best 25 Jak trees of 2 years and Rs. 15 for the best 5 bread-fruit trees of the same age in Yatinuwara Division. The Divisional Agricultural Officer to arrange rules for next meeting.

11. MR. J. C. RATWATTE, Dissawa, suggested that MR. JARDINE's paper on Banana Boring Beetle in plantains be circulated in vernacular. Resolved to ask the Director of Agriculture to supply up to 3,000 copies for distribution.

12. Tabled the results of the last Kandy Agricultural and Industrial Show. The Divisional Agricultural Officer addressed the planting members urging them to take a keener interest in the forthcoming Show in August 1924. Members present consented to do so.

MATALE.

Minutes of a meeting of the Matale District Agricultural Committee held on January 9, 1924, at the Matale Kachcheri with the Assistant Government Agent in the Chair.

There were also present MESSRS. F. VAN ROOYEN, W. A. UDUGAMA, Ratemahatmaya, Matale South and D. B. UDUWAWALA, Ratemahatmaya, Matale East.

1. Minutes of the previous meeting were read and confirmed.

2. *Rat and Crab Pests.*—Tabled papers *re* Rat and Crab Pests.

3. *Agricultural Shows and Competitions.*—Tabled leaflet re Agricultural Shows and Competitions 1923-24-Kandy District.

Considered application of the Co-operative Credit Society, Matale East, that the Rattota Agricultural Show be held in July and not in March or April. This application is supported by the Ratemahatmaya, Matale East. Resolved that the Show be held in July.

4. *Programme of work of Agricultural Instructor, Nalanda.*—Tabled Divisional Agricultural Officer's letter No. 3812 of 22.12.1923 and connected correspondence re programme of work of the Agricultural Instructor, Nalanda. In the absence of the Divisional Agricultural Officer and the Ratemahatmaya, Matale North, resolved to defer consideration till next meeting.

5. *Bunchy Top Disease.*—Tabled report of 10.12.1923 of MR. C. P. CRISPEYN, Agricultural Instructor, on the Rambukkana Experiment.

6. *Paddy Pests.*—Tabled the report re paddy pest at Kendangamuwa. Resolved to defer discussion on paddy pests till a later meeting.

7. *Cotton.*—Considered the question of cotton prices and steps to be taken to promote cotton cultivation in 1924.

Tabled letter of 5.1.24 of the Divisional Agricultural Officer announcing price which Ceylon Spinning and Weaving Company is prepared to pay for all Ceylon grown cotton 1923-24 crop. That has already been circulated.

(2) Resolved to ask the Assistant Government Agent in view of the desirability of increasing the land under cotton cultivation especially in Matale North, to deal with all applications for lease or purchase of land for cotton cultivation with the least delay possible; further to ask him to grant facilities for growing of cotton as a chena product. Subject of cotton production to be brought up again at the March or May meeting.

(3) Resolved that the Divisional Agricultural Officer be asked for further advice re purchase of cotton by Co-operative or other means so as to obtain good prices and to encourage production.

8. *March Meeting.*—Resolved that the March meeting be held on a day during the last ten days of that month; 10 days' notice to be given to members of the date.

POULTRY.

AN EASY METHOD OF BALANCING FOOD.

A. E. VANDEFORT.

To the poultryman who has worried over the problem of preparing balanced rations from feed tables giving the percentage of protein and carbo-hydrates the following method is simple.

Ever since the business of poultry-raising began to present tangible inducements in relation to profits there has existed an unheralded need for some simple, practical method of working out a balanced ration for laying hens. Until late years all such computations have had to be based on the nutrients of a food as shown by the chemical analysis. That is to say, the total digestible protein content of any food or mixture of foods is compared to the total carbo-hydrates, which are meant in this instance to include the fats multiplied by two and a quarter.

If, after comparing these two groups of food nutrients it is found that proportion of one to the other is suitable for the purpose for which the food or mixture of foods is intended, the product is called a balanced ration. Thus, for laying hens we say that the ratio of the protein to the carbo-hydrates should be about one to four and a half. In other words, for every pound of protein there should be four and a half pounds of carbo-hydrates.

All that one needs to work out a ration on this basis is a list of the common poultry foods, together with their chemical analysis, and a knowledge of the formula used. This formula calls for reducing the fats to carbo-hydrates by multiplying by two and a quarter, adding this product to the former and dividing the result obtained by the protein. It is a simple rule and has been written about and preached from the institute platform for more than a decade, yet we will venture the assertion that not one farmer in ten can take a list of foods in which the chemical analysis is given and work out a balanced ration for laying hens.

The problem itself is simple enough, but the form of presentation is not such as lends itself readily to the farmer's methods of figuring. At least that is our idea of why it has never impressed itself more firmly on that intensely practical citizen.

A new method of balancing rations is more simple. Instead of determining the availability of a food from the standpoint of protein, carbo-hydrates, fats, and so on, the nutrient contents of the various common foodstuffs is reduced to yolks and whites, for example, instead of giving the percentage of protein in 100 pounds of corn, the food value is given as 225 yolks and 134 whites.

The mere fact that the value of a food is expressed by the terms yolks and whites is in itself a wonderful improvement over the old system. It is not necessary now to go into long discussion to show why a ration is wide

or narrow, for anyone can appreciate at a glance that any food or mixture of foods which does not include an equal number of yolks and whites, and shells, can produce eggs only in proportion to the minimum number of any of the above substances. If a ration contains seventy-five yolks, twenty-five whites, and seventy-five shells, it is obvious that it can produce only twenty-five eggs. This mixture is wide and deficient in protein.

Following is a table giving the potential food values of the common foodstuffs in the terms of yolks and whites :—

	Yolks.	Whites.
Grain.		
Maize	255	134
Peas	189	305
Wheat	248	182
Oats	195	155
Barley	203	145
Buckwheat	178	128
Sunflower seed	233	266
Meat Food.		
Meat meal	106	1107
Dried blood	19	871
Green cut bones	196	336
Green Food.		
Lucerne	46	67
Clover	54	48
Cabbage	40	11
Rape	56	11
Liquids.		
Whole milk	44	60
Skimmed milk	22	52
Butter milk	22	65
Milk Products.		
Bran	155	205
Pollard	205	220
Maize Meal	260	135
Ground oats	195	155
Lucerne meal	133	205
Vegetables, Roots, etc.		
Apples	62	12
Mangel beets	19	18
Onions	11	25
Potatos	55	15
Turnips	26	16
Pumpkins	22	23

With this table before him, all that any farmer or poultry raiser has to do in compiling a balanced ration is to ascertain whether or not the totals of yolks and whites in the foods which he wishes to use are equal. If not equal, he has but to add or take away foods rich in yolks or whites until the desired result is obtained.

The following ration is given to illustrate the use of the table. Sale can be added at the rate of one pound to every hundred pounds of the mixture.

	Pounds.	Yolks.	Whites.
Grain.			
Maize	200	510	268
Mash.			
Pollard	20	41	44
Bran	20	31	41
Oats	20	39	31
Maize meal	20	52	28
Meat Scraps	26	27	88
Total ...	306	700	500

All rations can be supplied with 100 per cent, of shell and water if these substances are kept before the fowls at all times. As has already been stated, a balanced ration should contain an equal number of yokes and whites, yet all rations that contain the same number of these two substances are not necessarily good rations for egg production.

A good ration should be composed of the cheapest foods that will provide an equal number of yolks and whites, have sufficient bulk in the form of bran, lucerne meal, ground oats, and so on, to distend the intestines and assist digestion and to be palatable or relished by the fowls. Another point it will be well to bear in mind in making up a ration is that most of the feeding experiments to date have shown that animal foods, such as beef scrap, fish scrap, and milk, are more efficient sources of raw materials for the manufacture of whites than are the vegetable foods, such as oil meal and cotton seed meal. The latter are rich in whites, but do not seem to be especially palatable to the fowls.—SOUTH AFRICAN POULTRY MAG. AND SMALL-HOLDER, Vol. XVI, No. 142.

TOE-PECKING IN CHICKENS.

J. GRASHUIS.

During the summer of 1922, the author undertook the treatment of 150 pure-bred white Leghorn chickens only a few days old. He found the sick birds to have all lost part, or the whole, of one toe, while one toe was missing on the feet of those that had succumbed to the disease. Sometimes, the tail also was injured. It was very noticeable that all the birds thus affected had been in the habit of pecking their toes.

After trying various remedies, the author finally gave the chicks per head and per day 50 mgm. of "phosphone" dissolved in 200 gm. oleum jecorisaselli, 100 gm. of chalk and 50 gm. of kitchen salt.

The results obtained were very satisfactory, as after 5 days, the disease entirely disappeared. The treatment was continued for 10 days, and one month after it began, there was no sign of any recurrence of the malady. INTERNATIONAL REVIEW OF SCIENCE AND PRACTICE OF AGRICULTURE, Vol. I, No. 2.

GENERAL.

THE ARECANUT IN CEYLON.

W. MOLEGODE,

Agricultural Instructor.

Next to the coconut, the arecanut (*Areca catechu*), Sinhalese *Puwak* Tamil *Pakku*, is economically the most important palm grown in the Island. It is the commonest form of village vegetation in the wetter districts of the Island lying below 3,000 ft. elevation. Besides its extensive use by the people, being an indispensable ingredient of chewing so generally practised throughout the Island and the East, the arecanut is an important commercial product as is to be seen from the table of export trade appended to this article. Historically arecanut has attached to it an importance of no mean value. Prior to the British rule the arecanut was a valued commodity and was one of the Island's chief sources of revenue and exchange. In the Portuguese period it was the chief media of exchange or barter between the Kandyans and the Maritime Provinces. The Dutch considered and treated arecanut as the chief source of revenue and made an excellent trade of it jealously regulating its purchase and disposal. Trading with the Kandyan Provinces at this time was only permissible on a Passport from the Governor and a strict rule was made that all arecanut collected in the Kandyan country should be delivered at the Government Stores at a rate fixed by the authorities. The Government at Batavia fixed the buying and selling prices, and whatever the local Government made beyond the rates was considered the Governor's perquisite. The trade in the article at the time was very considerable and it has been recorded that the Dutch exported annually from twelve to fifteen thousands *Amunams* of arecanut (N.B.—The standard measure of the arecanut was the *Amuna*=24,000 dried nuts was the recognized equivalent of an *Amuna* which weighed between 280 and 290 lb.). The British Government when they took control of the Maritime Provinces left the arecanut trade perfectly free only imposing an export duty on it and the revenue from this source in the early British times amounted to one-fourth the revenue from Customs. Even at the present time it is one of the most important village crops. We have no pure plantations of arecanut as are to be found in India, except in the Kegalle district in which there have always been extensive plantations. At one time the extent under arecanut in the Kegalle district was 24,000 acres. In the times of the Kandyan Kings, Kegalle was the chief arecanut area and it still remains so. In the Kandy district during the last two decades a good amount of arecanut has been planted. In South Matale, in the eastern portion of Kurunegala district, in many parts of Uva, in all lower elevations of Nuwara Eliya district arecanut is a prominent feature of the village gardens being a favourite boundary tree and also planted along paths and drains and around compounds but in many instances the dense *arambas* of arecanut trees so commonly seen are

self-established having grown up from nuts that have dropped from the early planted trees. The area under this palm throughout the Island at the present time has been estimated to be 63,000 acres and the amount of arecanut exported per year is valued at over Rs. 3,000,000.

In Ceylon there are three recognised types of arecanut cultivated: (1) the Sinhalese Puwak which bears heavy bunches of a small size fruit; (2) Rata Puwak and (3) Hamban Puwak. The latter two produce larger sized fruits but do not form into *Karunka* or *Kalipakku* as well as the Sinhalese or common arecanut. In this the nuts are very close grained and therefore dry well and keep better when cured. The other two varieties are generally used in the raw state and are preferred to the Sinhalese variety because of their fragrant qualities and fetch better prices. The common variety is a heavy yielder. Occasionally single bunches containing as many as 1,000 fruits are seen. In the other mentioned varieties the fruits are much larger but the bunches are not so heavily laden. These two varieties have also the advantage of coming into bearing earlier than the common Sinhalese variety which takes 7 or 8 years to bear.

The arecanut is usually planted at close distances. The common practice is to put them at about 5 feet apart. In *Arambes* they grow huddled together and sometimes at a density of about 2,500 trees to the acre. A good distance to plant arecanut would be 7 feet by 7 feet thus giving 889 trees to the acre, although many plant 6 × 6 growing 1,200 trees to the acre.

The arecanut palm is well adapted to elevations below 3,000 feet where the rainfall is not low and is well distributed. It grows on most soils except rocky. It is a heavy surface feeder. Better the soil better the growth and crop as with all crops. Even on poor soil though the start is slow and poor arecanuts have been known to revive wonderfully. If good strong plants are to be obtained arecanuts must be planted in pits large enough—the larger the better. Holes one and half feet deep and foot square is the least size to be adopted. These should be half filled and the seed or plant put rather deep in the soil. Villagers plant in holes dug with one dig of the Alavango or Mamotie but such planting never produce the best results. Some advocate the planting of seedlings of at least 6 months. Some favour older plants of one and even two years, others prefer to plant the fruit itself in their places. The writer has seen and followed all the three methods adopted with equal success. What is most essential is the use of good seed. The villager is very indifferent about selection of seed, he obtains his seed supply from his own garden or from the adjoining garden because it is convenient but cares little about getting the best seed supply. Arecanut for planting must only be taken from a strong well developed tree of vigorous growth with healthy leaves bearing bigger branches than the average tree. The fruits must be quite ripe and possess all the characteristics of the type desired. They should be dried in the sun for a day or two and put in nurseries if plants are desired or planted in holes in situ.

The land should be kept clear of jungle growth and flowering weeds. Clean weeding is not necessary but a circle round each plant cleared of all grass should be made. Careful draining is not required but the soil around plants should not get water-logged. When the plants are established little

further attention is necessary. Grown under good conditions the arecanut palm will begin to yield from about the 7th or 8th year and continue to bear full crops till about the twentieth year after which the yield begins to be irregular and nuts smaller in size.

All calculations of yields have hitherto been based on 1200 tree to the acre. Reckoning on an average yield of 300 nuts per tree it has been estimated that 30 cwt. of arecanut would be a fair average crop per acre but it would be safer to estimate a yield of 20 cwt. from 890 trees giving an average of 3 lb. *Kalipakku* per tree or the same weight of *Karunka* from the Sinhalese Puwak and an average of 250 nuts from a tree of Hamban and Rata Puwak. These latter are almost always sold in ripe undried state and ordinarily fetch Rs. 1 to Rs. 1·25 per 1,000 though this year the price rose to Rs. 2·50 to Rs. 3·50 per 1,000 fruits. The *Kalipakku* usually sells at Rs. 28 to Rs. 30 per cwt. at the local markets.

At the time of writing there is a great demand for all types of arecanut and the current prices on 15th October are :

Ripe arecanut

Rata or Hambanpuwak	...	Rs. 2·50 per 1000
Sinhalese Puwak	...	Rs. 1·50 to Rs. 1·75 per 1000

Kalipakku

Ist grade	...	...	Rs. 40·00 to Rs. 42·00 per cwt.
2nd grade	...	...	Rs. 35·00 to Rs. 38·00 per cwt.

Karunka or Kattapakku— ... ... Rs. 24·00 per cwt.

The arecanut tree itself is very largely used and valued as a building material for temporary structures and semi-permanent buildings. The hard stem gives a useful wood which is used as reepers, rafters and for wattle and daub walls and in making handles for spears, knives, katties, etc., and in various other ways.

The leaf sheath is used chiefly for making buckets and utensils for drawing and carrying water and bags for holding fruits, flowers, sweetmeats, etc. It is also sometimes used as plates and cups.

The inflorescence is indispensable in the carrying out of various religious ceremonies and is a chief offering at temples and altars. Every part of the areca palm is made use of in Ceylon.

More than any other tree the arecanut is preferred by the villager as standards for betel and pepper vines and for running the heavier varieties of yam creepers.

Quantities and Values of Exports of Arecanuts from Ceylon.

Year.	*Quantity.*	*Value.*
	Cwt.	Rs.
1909	149,649	2,378,476
1912	115,891	2,824,690
1914	93,200	1,798,439
1915	171,854	3,345,711
1916	123,205	2,804,500
1917	154,000	2,954,001
1918	214,780	3,801,682
1919	150,457	3,059,158
1920	124,048	2,923,822
1921	131,045	3,303,073

BANDAKKA AND ITS VALUE.

W. MOLEGODE,

Agricultural Instructor.

Bandakka, Okra, or Ladies Finger (*Hibiscus esculentus*) is a well-known vegetable cultivated throughout the Island but its excellent properties as a nutritious vegetable possessing considerable medicinal properties has been little realised. It is one of our most esteemed vegetables and is extensively cultivated being easily raised from seed and is largely used by all classes. The Bandakka is a herbaceous annual belonging to the *Malvaceæ* and is regarded as of African origin, but is now naturalised in all tropical countries. It is cultivated for its fruits or capsules which are from six to twelve inches long, about an inch in diameter, ridged and bristly in some varieties and round or slightly ridged and free of bristles in some varieties. These fruits in their unripe state are much esteemed as vegetable and are prepared in various ways. They abound in mild mucilage possessing valuable emollient and demulcent properties and is used in cases of catarrhal affections, fevers, irritable state of the bladder, etc. In hoarseness and in dry irritable state of the throat causing troublesome cough, a soup prepared by boiling down a few unripe bandakka in about a pint and half of water and taken after straining and sweetening to taste has proved beneficial in the case of the writer. Sometimes a free inhalation of the vapour of this hot 'Bandakka Soup' has been known to act wonderfully on dry troublesome coughs and hoarseness. In cases where there is difficulty in passing urine the 'Bandakka Soup' has acted very beneficially. The leaves of the bandakka plant are used externally as an emollient poultice.

The plant yields a white silky strong fibre very much like Rosella fibre.

CULTIVATION.

Bandakka is readily raised from seed. As a garden crop it is best grown on hills. Prepare holes 1 by 1 ft. and 3 feet. apart. Fill these up with a good mixture of loose soil and manure. Sow 2 or 3 seeds in each of these holes. When plants are about 6 inches high thin out leaving only the sturdiest plant. Young plants do not transplant with ease. In three months' time fruits could be gathered. These should be picked while they are tender. When ripe they are tough and fibrous. When the plant has grown to five feet top off and allow it to spread.

There are now three distinct varieties generally grown but the best is the slightly ridged, round, smooth variety with a white velvet appearance and comparatively free from spiny hairs or bristles. These are known in the Sinhalese districts as Japana Bandakka.

MARKET RATES.

MARKET RATES FOR SOME CEYLON PRODUCTS.

(FROM THE CEYLON CHAMBER OF COMMERCE WEEKLY PRICE CURRENT, DATED 14th JANUARY, 1924).

NAME OF PRODUCE		CURRENT PRICE Rs. cts.	at	Rs. cts.	REMARKS
CARDAMOMS					
All round parcel well bleached	per lb.	...	,,	...	
Do do medium	do	...	,,	...	
Special assortment O & I only	do	...	,,	...	
Seeds	do	...	,,	...	
Green	do	2 75	,,	2 82	
CINNAMON QUILLS—[At Buyer's Stores]					
Ordinary assortment (in bales of 100 lb. nett)	per lb.	0 56	,,	0 60	
No. 1	do	0 58	,,	0 62	
No. 2	do	0 56	,,	0 60	
No. 3	do	0 54	,,	0 58	
No. 4	do	0 52	,,	0 56	
CINNAMON CHIPS—Maradana, (At Buyer's Stores) (in bags of 56 lb. nett) per candy of 560 lb.		55 00	,,	65 00	
CITRONELLA OIL—(ex-Seller's Stores without packages) ...	per lb.	2 00	,,	2 05	Nominal
CACAO—(At Buyer's Stores)					
Estate—Finest	per cwt.	46 00	,,	53 00	
Do Medium	do	30 00	,,	45 00	
Do Common (Black)	do	20 00	,,	32 00	
COCONUT—(Desiccated) Granulated goods (Delivered at Wharf or Buyer's Stores) ... ... Assortment: Medium 50 per cent, Fine 50 per cent. ...	per lb.	0 24	,,	0 25	
COCONUT OIL—					
White Oil f.o.b	per ton	635 00	,,	645 00	
Ordinary Oil do	do	605 00	,,	615 00	
COPRA—					
Calpentyn	No. 1 quality per candy of 560 lb.	90 00	,,	95 25	
Estate	do 560 ,,				
Ordinary quality (Maravila)	do 560 ,,				
Cart Do do	do 560 ,,				
FIBRES—(At Buyers' Stores)					
Coconut Bristle No. 1	per cwt.	13 80	,,	14 75	
Do No. 2	do				
Coconut Mattress No. 1	do	2 75	,,	3 00	
Do No. 2	do				
Coir yarn, Kogalla No. 4 to 9	do	13 00	,,	22 00	
Do Colombo No. 3 to 7	do	13 00	,,	15 50	

PLUMBAGO		X. B. Rs. cts.		Rs. cts.	B Rs. cts.		Rs. cts.	B. E. Rs. cts.		Rs. cts
Ordinary Lumps	per ton	300 00	at	350 00	225 00	at	275 00	175 00	at	200 00
Chips	do	200 00	,,	250 00	150 00	,,	200 00	100 00	,,	160 00
Dust	do	125 00	,,	175 00	75 00	,,	125 00	50 00	,,	75 00
Do Flying	do	75 00	,,	145 00	50 00	,,	90 00	30 00	,,	60 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1924.

Province, &c.	Disease	No. of Cases up to date since Jan 1st, 1924	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	51	51	11	36	4	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—
Colombo Municipality	Rinderpest	82	82	—	—	—	—
	Foot-and mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	22	22	—	22	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	1	1	—	1	—	—
	Piroplasmosis	2	2	—	—	2	—
	Rabies	—	—	—	—	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	1	1	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest Foot-and-mouth disease Anthrax	Free					
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	1	1	1	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	5	5	3	2	—	—
	Foot-and-mouth disease	25	25	10	—	15	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest Foot-and-mouth disease Anthrax Piroplasmosis	Free					
Uva	Rinderpest Foot-and-mouth disease Anthrax Piroplasmosis Hæmorrhagic Septicæmia Tuberculosis Rabies	Free					
Sabaragamuwa	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	76	76	29	—	47	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	—	—	—	—	—	—
	Rabies	—	—	—	—	—	—

M. CRAWFORD,
for Government Veterinary Surgeon.

Colombo, 8th February, 1924.

METEOROLOGICAL
JANUARY, 1924.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
			%			Miles.	Inches		Inches
Colombo Observatory	80·1	+1·0	78	4·4	NNE	141	2·56	7	- 1·00
Puttalam	78·4	+1·0	78	4·0	NNE	153	2·59	10	- 0·09
Mannar	79·2	+0·4	80	5·4	NNE	278	2·91	10	+0·19
Jaffna	77·8	+0·4	78	6·6	NE	82	2·99	7	+0·45
Trincomalee	78·0	-0·7	82	6·6	NNE	221	7·83	16	+1·29
Batticaloa	78·2	+0·4	82	6·8	NNE	194	13·15	17	+2·95
Hambantota	79·2	+0·8	81	3·7	NE	342	5·35	11	+2·01
Galle	79·2	+1·0	84	5·4	Var:	111	2·10	10	+2·21
Ratnapura	81·6	+1·8	76	5·8	—	—	5·05	16	- 0·28
Anu'pura	76·3	- 0·1	84	5·6	—	—	4·65	10	+0·70
Kurunegala	78·2	+0·2	78	5·0	—	—	0·87	6	- 2·79
Kandy	76·2	+1·8	75	5·0	—	—	2·43	11	- 2·79
Badulla	71·3	+1·1	86	7·5	—	—	5·59	19	4·12
Diyatalawa	65·8	+1·2	80	7·6	—	—	3·74	14	- 2·44
Hakgala	58·2	+1·2	92	7·4	—	—	7·90	20	1·73
N.' Eliya	59·2	+1·8	85	6·8	—	—	3·56	14	- 2·09

Throughout January the North-East Monsoon dominated the weather, though the depression that was active in the Bay of Bengal towards the end of last month may have helped to produce the thunderstorm type of weather that was generally experienced over the Island during the first week.

Over the greater part of the Island there was considerably more rain in the first half of the month than the second, while the total for the whole month did not differ greatly from normal. Precipitation was heaviest immediately to the North and East of the hills, and in the Eastern Province, but in more than half the Island the average was not reached, deficits of from two to five inches being particularly common.

On the other hand rainfall was above average (by small amounts) in quite a number of districts, though there was no large area throughout which this was consistently true, the nearest approaches to it being in the Kelani Valley and round Matara and Trincomalee.

Of the returns so far received Dooroomadella with a total of 23·66 inches and Keenakelle with 21·58 head the list while the heaviest falls in one day occurred at Urubokka, 7·60; Keenakelle, 6·11; Lahugalla, 5·78 and Sakamam 5·16 inches. Only one station (Talaimannar) failed to record any rain at all.

Air pressure was above normal and more so to the North than the South which explains the strong Northerly winds experienced. Heavy Northerly winds of great force were reported from stations during the last few days of the month.

Clouding was above normal to the North, East and Upcountry. Humidity followed the same distribution but was much heavier than usual upcountry.

As may be seen from the above table and despite the stronger Northerly winds the temperature was at most stations higher than usual.